MERRIMACK RIVER BASIN
ASHLAND, NEW HAMPSHIRE

SQUAM LAKE DAM
NH 00059

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS, 02154

OCTOBER 1978

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KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

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Merrimack River Basin
Ashland New Hampshire
Squam River

ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The dam is a low concrete and masonry gracity structure. The overall length of the dam is about150 ft. and has a height of 18 ft. above the river bed level. The overall physical condition, as a result of reconstruction. The basis for hydraulic eapacity or stability is poorly documented.

FORM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

OCT 5 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Squam Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

SQUAM LAKE DAM
NH 00059

MERRIMACK RIVER BASIN

ASHLAND, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Squam Lake Dam, I.D. NH 00059
State Located:	New Hampshire
County Located:	Grafton
Town Located:	Ashland
Stream:	Squam River
Date of Inspection:	June 5 and 6, 1978

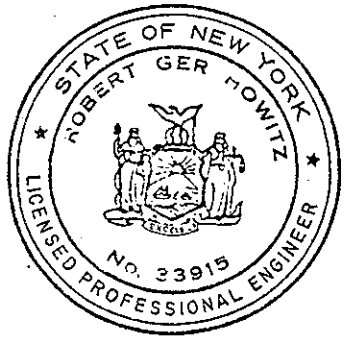
BRIEF ASSESSMENT

Squam Lake Dam is a low concrete and masonry gravity structure. The overall length of the dam is approximately 150 feet and has a height of 18.0 feet above the river bed level. The spilling has an ogee crest divided into 4 stop plank sections approximately 5.5-foot long. The stop planks are normally in place to a depth of 5 ft.-8 in.

The overall physical condition of the dam is good as a result of reconstruction carried out in 1968. This dam has existed in one form or other since 1856 and has been extensively modified after failures or near failures in 1902, 1927 and 1968. The basis for hydraulic capacity or stability is poorly documented. The dam has an inadequate spillway capacity and is capable of passing 22 percent of the Spillway Design Flood (SDF) which is this case is the Probable Maximum Flood (PMF). This assessment is made on the basis that no stop logs have been removed from the permanent concrete spillway at the time of the SDF. If all stop logs were removed down to the permanent crest level, the dam is capable of passing more than one half of the Probable Maximum Flood (PMF). The spillway capacity was determined according to Corps of Engineers screening criteria and the owner should compute the spillway capacity using more sophisticated and accurate methods and procedures.

Recommended actions to be carried out by the owner within 12 months after receipt of this Phase I Report are summarized in Section 7. The most impostant of these is the acquisition of sufficient data to produce a comprehensive as-built set of drawings for the dam and its foundation. Remedial work consists of clearing trees and brush from the area downstream of the right abutment and providing a permanent closure for an abandoned penstock, if no future use for this pipe is found.

Robert Gershowitz, P.E.



This Phase I Inspection Report on Squam Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe condition be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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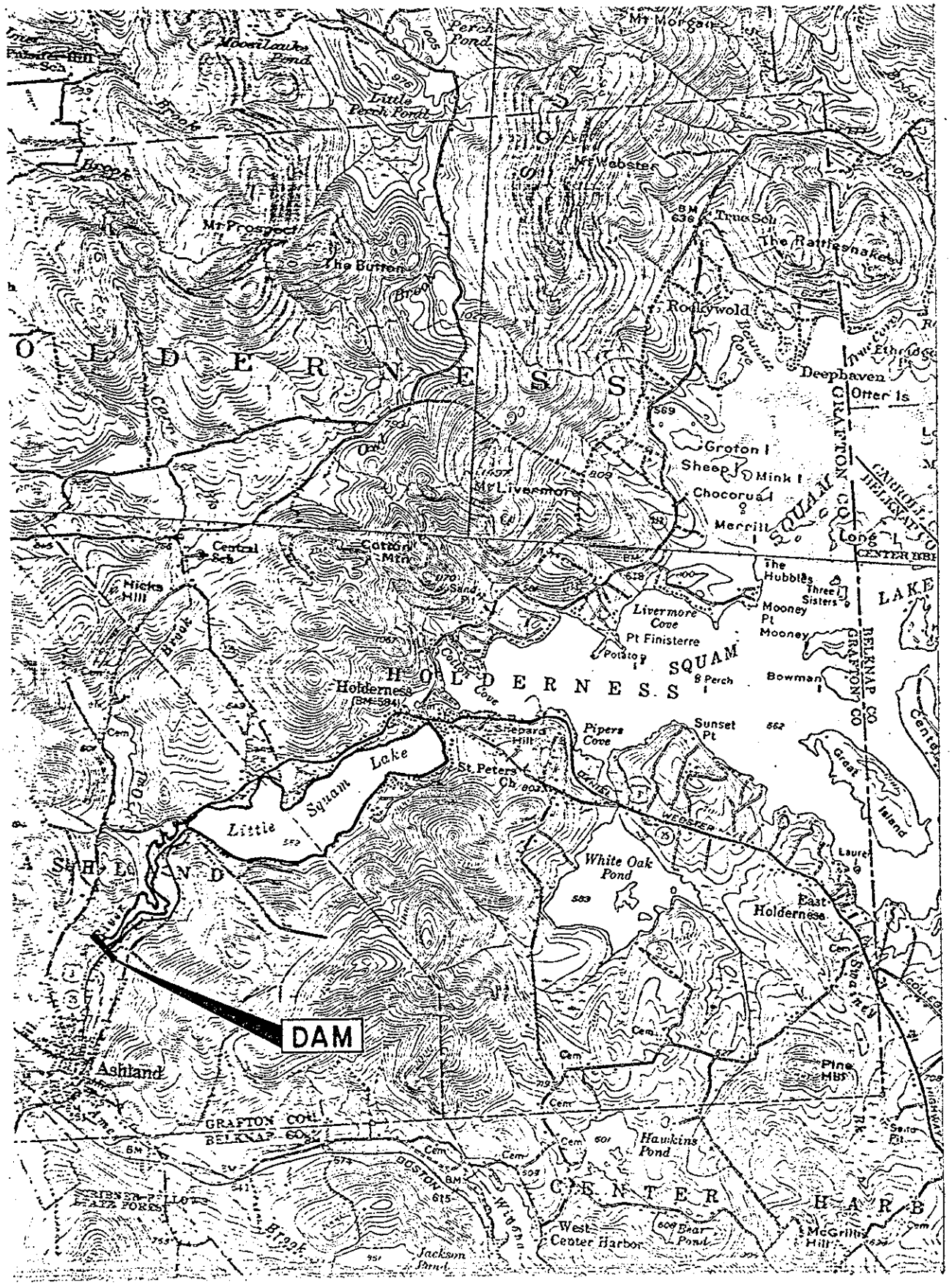
View of the spillway section showing the permanent concrete weir and the stop planks surmounting the ogee crest. The low level outlets are submerged below the tailwater level directly beneath one of the three visible piers. Stone works on right of picture dates back to original construction in 1856.



Quadrangle: Holderness, N.H.
Scale: 1" = 2000'

VICINITY MAP

PHASE I INSPECTION REPORT

SQUAM LAKE DAM NH 00059

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. HARRIS-ECI ASSOCIATES has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to HARRIS-ECI ASSOCIATES under a letter of June 7, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0305 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of the Project

a. Location

Squam Lake Dam is located on the Squam River in the Town of Ashland, Grafton County, New Hampshire. The dam is located approximately 0.8 mile upstream of the village of Ashland. Squam River is a tributary of the Pemigewasset River and is part of the Merrimack River primary drainage basin.

b. General Description of the Dam and Appurtenances

Squam Lake Dam is a low concrete and masonry gravity structure impounding the waters of the Squam River, approximately one mile south and downstream of the natural outlet of Little Squam Lake. The dam site has been used since 1856, and the present structure incorporates part of the original masonry walls built in 1856 and has been modified in 1902, 1927, and 1968. The central section of the dam was rebuilt in 1927 and contains a 22-foot long ogee spillway and three 4 x 4.5 foot low level outlet sluice gates. The spillway crest is broken into 4 stop plank sections. Stop planks are normally in place to depth of 5 ft.- 6 in. above the permanent spillway crest. The low level outlets are controlled by timber sluice gates on the upstream side of the dam operated by hoists located on an operating deck above the spillway deck. The spillway and low level outlets are protected by fish screens on the upstream side. The concrete spillway adjoins an older cut stone abutment training wall on the left which has been raised and extended in 1968. New fill has been added on the downstream side of this wall to correct leakage conditions observed there in 1967. On the right, the spillway section adjoins an old masonry wall probably dating to the original construction. This wall has been raised by the addition of parapet wall, and runs into the adjacent hillside.

The overall length of the dam is estimated at approximately 150 feet and has a height of 16.5 feet above the river bed level.

The dam contains a 66-in. diameter steel penstock passing through the dam's right abutment masonry section, and a 20-inch diameter penstock passing through the left abutment section, used formerly for power generation. Currently, both penstocks are cut off downstream of the dam and are abandoned.

The dam is founded on a soil subbase reinforced by a timber log crib built in 1856. In 1927, a steel sheet piling cutoff was installed under the upstream end of the approach apron and tied into it.

The dam impounds and controls the levels in Little Squam Lake and Squam Lake. Both lakes are connected by a short connecting channel at Holderness, New Hampshire, and have a common water level surface. The total area of both lakes is 7,173 acres, impounding a total of 39,600 acre-feet of water derived from a watershed of 58 square miles. A one-mile submerged section of the Squam River connects the natural parts of Little Squam Lake to the dam.

The downstream channel of the Squam River is well defined. A U.S.G.S. gaging station is located some 300 feet downstream of the dam. There are some residences on the left bank both upstream and downstream of the dam axis. The village of Ashland with a population of 1,300, is located approximately 0.8 mile downstream of the dam along the banks of the Squam River.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection" by the U.S. Department of the Army, Office of the Chief of Engineers, the dam is classified in the dam size category as being "Intermediate", since its storage is more than 1,000 acre-feet but less than 50,000 acre-feet. The dam is also classified as "Small" because its height is less

than 40 feet. The overall size classification is determined by the larger of these classifications, and thus Squam Lake Dam is classified as "Intermediate" in size.

d. Hazard Classification

The dam has been classified as having a High Hazard Potential in the National Inventory of Dams in the United States maintained by the U.S. Army Corps of Engineers, on the basis that in the event of failure of the dam and its appurtenances, excessive damage could occur to downstream property together with the possibility of the loss of more than a few lives. The present inspection concurs with this assessment for the following reasons:

(1) The dam is built on an erodible foundation, that can wash out in a case of an accident.

(2) The amount of impounded water is large and the surface area of the impoundment is also large.

(3) The site has experienced two prior dam accidents, in 1902 and in 1927, in which disaster was barely averted. The dam also experienced a piping type failure in 1967 leading to a general rehabilitation in 1968.

(4) The downstream community of Ashland would have only approximately 4 to 5 minutes warning in case of a dam accident, which is not enough to implement adequate evacuation and warning procedures.

e. Ownership

Squam Lake Dam is owned by the New Hampshire Water Resources Board, located at Concord, New Hampshire.

f. Operator

The Squam Lake Dam is operated by the N.H. Water Resources Board, headquartered at Concord, New Hampshire - Telephone: (603) 271-3405.

g. Purpose of Dam

The dam is currently operated as a State facility for recreation, conservation and flood control. In former times, the dam supplied power for mill operation and electricity.

h. Design and Construction History

The original dam was constructed in 1856, and parts of the masonry abutments and timber log crib foundation are apparently still in use. After a failure in 1926, the spillway was rebuilt in 1927 according to design drawings made by I.W. Jones Company, Engineers, of Milton, N.H. A steel sheet pile cutoff was driven at the upstream end of the existing apron slab and tied into the slab with additional concrete. In 1964, the ownership of the dam passed from the Town of Ashland to the N.H. Water Resources Board. The dam underwent a general rehabilitation in 1968, after a piping failure incident on the left abutment. The dam's masonry was refaced and the dam's crest was raised at several places. The left abutment cutoff wall was lengthened and new backfill was placed in the area downstream of the left abutment.

i. Normal Operating Procedures

The normal operating procedure is to regulate the stream flow through the low level outlet sluices, keeping the spillway flashboards in place at the nominal lake elevation. According to analyses made by the N.H. Water Resources Board, the normal lake levels are regulated as follows:

(1) In the period between June 1 to October 30 of any year a lake level will be maintained at no higher than Elevation 563.0 MSL and no lower than Elevation 560.5 MSL.

(2) The level of the lakes will be lowered to Elevation 60.5 after October 1 of any year and maintained at that level until February 1st of the year following.

(3) Discharges in the period of February 1 and June 1 of any year, are adjusted to achieve a lake level no higher than 563.0 MSL by June 1st, based on an estimate of snow cover within the watershed and its water content.

1.3 Pertinent Data

a. Drainage Area	58 square miles
b. Discharge at Dam Site	
Maximum known flood at dam site:	1,090 cfs, July 4, 1973
Warm water outlet at pool elevations:	NA
Diversion tunnel low pool outlet at pool elevation:	NA
Diversion tunnel outlet at pool elevation:	NA
Gated pilwway capacity at pool elevation:	NA
Gated spillway capacity at maximum pool elevation:	NA
Ungated spillway capacity at maximum pool elevation:	• 64 cfs (stop logs in place to El.563.0 and upstream water surface at El.564.75) • 1436 cfs (no stop logs, upstream water surface at Elev. 564.75)
Total spillway capacity at maximum pool elevation:	As above
c. Elevation (Feet above MSL)	
Top of dam:	564.75
Maximum pool design surcharge:	563.0
Full flood control pool:	563.0
Recreation pool:	563.0
Spillway crest:	557.8, Fixed concrete crest
Upstream portal invert diversion tunnel:	NA
Downstream at centerline diversion tunnel:	NA
Streambed at centerline of dam:	548.25
Maximum tailwater:	559.8 (estimated)

d. Reservoir

Length of maximum pool:	10.65 miles
Length of recreation pool:	10.56 miles
Length of flood control pool:	NA

e. Storage (acre-feet)

Recreation pool:	39,600 AF
Flood control pool:	NA
Design surcharge:	NA
Top of dam:	52,989 AF

f. Reservoir Surface (acres)

Top of dam:	7,745 Ac.
Maximum pool:	7,450 Ac.
Flood control pool:	NA
Recreation pool:	7,450 Ac.
Spillway crest:	7,450 Ac.

g. Dam

Type:	Concrete and masonry, concrete ogee spillway and outlet section
Length:	150 feet (estimated)
Height:	18 feet
Top width:	Varies, 5 to 6 feet
Side Slopes - Upstream:	) Varies, near vertical
- Downstream:	)
Zoning:	None
Impervious core:	None
Cutoff:	) Steel sheet piling under upstream) apron slab
Grout curtain:	None

h. Diversion and Regulating Tunnel

Type:	NA
Length:	NA
Closure:	NA
Access:	NA
Regulating facilities:	NA

i. Spillway

Type:	Concrete ogee
Length of weir:	22
Crest elevation:	557.8 (estimated)
Gates:	) None, controlled by flashboards) 5'-8" high above permanent crest
U.S. Channel:	Squam River, submerged reach
D/S Channel:	Squam River

j. Regulating Outlets

Low level outlet:	3 passages, 4 ft.wide x 4.5 ft. high
Controls:	Wooden sluice gates, upstream face mounted manual gate hoist
Emergency gate:	None
Outlet:	Apron slab downstream of sluice outlet leading into the natural channel of the Squam River

SECTION 2

ENGINEERING DATA

2.1 Design

Drawings in the files of the N.H. Water Resources Board (NH-WRB) relate to the 1927 reconstruction of the spillway. The drawings were prepared by I.W. Jones Co., Engineers, Milton, N.H., for the Town of Ashland, the owner of the dam at that time (refer to Drawings 1 through 4). These drawings are considered adequate for their purpose, but do not include any significant details of the adjacent masonry sections which have been constructed and possibly modified prior to 1927. The cutoff shown on these drawings is a steel sheet pile system which was actually installed, based on an available report. The modifications made in 1968 are shown on Drawing 5. These modifications were made by the NH-WRB after a piping failure appeared on the landward side of the left abutment masonry wall. The drawings available do not adequately describe the dam as it stands today. Major gaps in information include:

(1) The dam is not tied into the U.S.G.S. level system, instead a river bottom datum was used.

(2) No sections are given on critical abutment and non-overflow sections.

(3) The modifications in 1968 are inadequately dimensioned and detailed.

(4) Fill placed on the left abutment is inadequately dimensioned and detailed.

The hydrologic and hydraulic design basis of the existing modified structure is inadequately documented, and no computations for spillway capacity were uncovered. No computations for a spillway discharge rating curve, a low level outlet rating curve or a tailwater rating curve at the dam were uncovered. A simplified hydrologic analysis made in 1929 assumed a 9-inch rainfall over the drainage area of the watershed which is considered inadequate by present-day standards. No attempts at routing flood flow through the reservoir were made.

No computations relating to structural stability, seepage analysis and foundation properties were uncovered to check the design basis of the reconstructions of 1927 and 1968.

2.2 Construction

Only a one brief letter memorandum was found in the files of the NH-WRB dealing with the reconstruction of the spillway in 1927. It does contain data useful in piecing together and verifying information available in other documents available for review. No systematic log of construction activities has been recovered.

2.3 Operation

Operating records relevant to the dam inspection process include water level records for both Squam Lakes in the years 1941-1964 and discharge records for Squam River at a point 300 feet downstream of the dam for the years 1940-1977 which give a good idea of the fluctuations of the lake levels over an extended period of time.

In the years 1941-1965, the lake level never rose above Elevation 563.3 as compared to the top of dam which is estimated to have an elevation of 564.75. As far as is known, this dam was overtopped only once, when the discharge of record occured, 1,090 cfs on July 4, 1973. The overtopping depth was estimated at 3 inches.

The 1,090 cfs discharge apparently also inundated overbank areas in the vicinity of the gage, judging from the gage height observed at that date. Normally flows of 225 cfs are the maximum that have been released during non-storm periods, since discharges in excess of this amount have caused downstream flooding and damage.

2.4 Evaluation

a. Availability

The availability of data is fair to poor. Although the 1927 reconstruction is well documented with drawings, the 1968 reconstruction is poorly defined in the one drawing recovered from NH-WRB files. No plans, sections or details are available for the original construction on both abutments. No pertinent data was available for review on hydrology, spillway capacity, flood routing through the lake, spillway, low level outlet and tailwater rating curves, stability, seepage analysis or foundation conditions. The dam is not definitively tied into the U.S.G.S. level system.

b. Adequacy

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is bases primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity

The information recovered for the 1968 reconstruction is not considered valid since it does not correspond at all with what was seen at the dam during the field inspection.

The documents for the 1927 reconstruction appear to match existing conditions, making allowances for the work performed in 1968. The fish screen details upstream of the spillway and low level outlets are not shown on these drawings.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

The physical condition of Squam Lake Dam is good, as a result of a reconstruction performed by the N.H. Water Resources Board (NH-WRB), in 1968.

b. Dam

(1) Spillway and Low Level Outlet Section. The spillway section is located in the center of the dam, aligned with the channel of the Squam River. The spillway has an ogee crest divided into 4 sections by walkway piers. Each section is approximately 5.5-foot long. The fixed crest is surmounted by stop planks, each 2 1/2 x 7 1/2 inches in dimension and supported by grooves in the sides of the piers. The total height of stop planks in place was 5.5 feet on the day of inspection. There are low level outlets, each 4-foot wide by 4.5-foot high, located in plan under the center of each of the 3 intermediate spillway piers. The concrete construction dates to 1927 and shows signs of surface roughening due to water erosion and freeze-thaw spalling. The greatest deterioration visible is at the downstream end of the spillway piers above the ogee surface of the spillway. The concrete walkway on top of the spillway piers and the deck over the fish screens upstream of the spillway appears to be part of the 1968 reconstruction and is in good condition. The entire spillway is founded on a thick slab which extends upstream and downstream as an apron. This part of the structure could not be inspected due to headwater and tailwater depths prevailing.

(2) Abutment Sections. To the right of the spillway section, a non-overflow section connects the spillway with high ground on the abutment. The non-overflow section is built of cut stone masonry, which has cemented joints on the downstream face, instead of the usual dry wall construction characteristic of the area and period. This wall is believed to be part of the original dam structure dating to 1856. The foundation of this wall is unknown and not determinable in the field. The original masonry wall has been raised by concrete facing on the upstream side to bring it up to the level of the spillway operating deck. All masonry work is in acceptable condition, and the concrete surfaces are in good condition, probably dating to the 1968 reconstruction. No leakage was observable at the downstream side of the wall.

The wall is penetrated by a 66-inch diameter penstock, used in former years to supply water to a hydraulic turbine for electric power generation. The penstock is presently cutoff approximately 20 feet downstream of the masonry wall. It is closed off by its own gate. The area downstream of the right abutment is overgrown with brush and trees in a wild state.

The left abutment section consists of a massive cut stone masonry pier probably dating back to the original construction which has been modified and capped with concrete. The pier is of dry wall construction and the large stones are well interlocked. The abutment wall has been raised 25 inches in 1968, by the addition of a concrete parapet wall which has been backfilled on the downstream side to the top of parapet. This abutment parapet wall has been extended into the left abutment area forming the cutoff. The left abutment is under cut grass cover and provides the main access to the dam from River Road which runs parallel to and east of the river at the dam. No leakage or seepage was detected downstream of this section of the dam.

The sink hole leak reported in 1968 has apparently been remedied by the reconstruction. The specific actions taken were to concrete face the masonry on the reservoir side of the abutment wall and adding fill on the downstream side of the parapet wall.

c. Appurtenances

(1) Sluice Gates Hoists. The sluice gates are mounted on the upstream face of the concrete spillway section controlling openings that are 4-foot wide and 4.5 ft.high. The gates are made of timber with cast iron operating mechanisms. The manually powered operators use a combination of worm gearing and spur gearing to drive a rack mounted on the gate stem. The operating mechanisms and the visible portion of the stems appeared to be in satisfactory condition. The left gate and the center gate were operated during this inspection and functioned satisfactorily. The operating mechanisms are anchored to the concrete slab which forms a walkway over the stoplog area. At a few locations where the anchor bolts pass through the slab, the concrete has spalled and broken away; however, these broken area are so situated that the strength of the gate hoist foundation is not affected.

(2) 66-inch Diameter Penstock through the Right Non-overflow Section of the Dam. This abandoned and cutoff penstock at one time led to a mill situated immediately downstream of the dam. On the upstream face of the dam, a manually operated sluice gate seals the entrance to the penstock. This gate is no longer used and is simply left in the closed position. There was no discernible leakage coming from the open end of the penstock. This gate should either be repaired as necessary for use as an additional low level outlet or dismantled and the penstock permanently sealed. Plans for permanently sealing this penstock are in the files of the NH-WRB, but as far as could be determined, this modification was not carried out.

(3) Stop Planks on the Spillway Crest. The four sets of stop planks are located on top of the spillway crest, directly above the sluice gate outlets. The stop logs consist of 2 1/2 in. x 7 1/2 in. timbers cut to the proper length and placed in the retaining slots, one on top of another. Each set of stop planks is approximately 5.5-foot wide. The individual logs are equipped with eyebolts, one on each end, to facilitate installation and removal. The stop planks appeared to be in acceptable condition. Normally, the stop planks are left in place at the desired reservoir elevation and the outlet flow is controlled by positioning of the sluice gates.

(4) Gaging Equipment. Downstream of the dam axis, a U.S.G.S. gaging station "Squam River at Ashland" has been installed consisting of a gaging weir, a float well, two paper take recorder and a staff gage. Discharge records are available from 1940 on. The gage appears to be operating properly.

Upstream, on the lake side of the dam, a staff gage, a float well and Telemark gage have been installed in the connecting channel between Squam Lake and Little Squam Lake. These instruments indicate and transmit the level to the NH-WRB headquarters in Concord, N.H. The equipment was operational on the day of inspection.

d. Reservoir

The slopes of the approach channel to the dam were gentle to moderately steep and exhibited no readily apparent signs of instability. A cursory inspection of the reservoir slopes of the main body of the lakes indicated similar type slopes, again showing no visible signs of instability. No evidence of sedimentation in the approach was discernible. It is unclear to what extent the level of the two Squam Lakes can be drawn down because of the shallowness of the outlet channel leading to the dam from Little Squam Lake and the connecting channel between Little Squam Lake and Squam Lake at Holderness.

e. Downstream Channel

The channel is well defined and unobstructed in the reach downstream of the dam. River Road crosses the Squam River 500 feet downstream of the dam. The river banks slope at 1 on 2 horizontal, and are approximately 8 to 10-foot high at the dam axis, gradually getting shallower going downstream. The village of Ashland, with a population of 1,300, is 0.8 of a mile downstream along the banks of the river.

3.2 Evaluation

The overall physical conditon of the dam is good, due to its major rehabilitation work in 1968. No conditions were uncovered during the visual phase that require further examination and review.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures

Squam Lake Dam is currently used for recreation, conservation and flood control purposes. The lake elevation is closely monitored by a gage located along the connecting channel between Little Squam Lake and Squam Lake at Holderness. Lake level information is recorded and telephonically transmitted to N.H. Water Resources Board (NH-WRB) headquarters in Concord, N.H. Control of the lake surface is accomplished by varying the openings of the three sluice gates, or in the case of major inflows, by removal of stop planks in the spillway section. Normally a discharge of 75 cfs is released to satisfy downstream needs; however, minimum discharges of 60 cfs have been acceptable in the past. Discharges greater than 225 cfs are avoided if possible, because of downstream inundation and damage at this discharge volume. Sluice gate opernings are controlled by NH-WRB engineers at Concord; whenever the dam operator visits the dam he checks in telephonically with headquarters which issues instructions on desired gate openings. The targeted seasonal lake levels have been discussed in Section 1.2.i. above. Water releases at the dam are based on meeting targeted lake levels and are affected by hydrological events such as snowmelts and severe rainstorms.

4.2 Maintenance of Dam

The dam is maintained on an as-needed basis based on reports of the dam operators.

4.3 Maintenance of Operating Facilities

Operating facilities are maintained on an as-needed basis in conjunction with visits to the dam by the dam operators.

4.4 Description of any Warning System in Effect

There is no warning system in effect that would alert downstream residents in case of a dam accident.

4.5 Evaluation

The operational procedures at the dam are simple fitting in with the simple facilities involved. In line with greater public interest in dam safety, the owner should institute an annual dam inspection utilizing a simplified version of the visual check list used in this inspection report. The reports should be kept on permanent file. Maintenance schedules should be drawn up and all visits to the dam logged in a permanent record, whether for maintenance or dam operation.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The evaluation of the hydraulic and hydrologic features of the Squam Lake Dam was based on criteria set forth in the Corps' Guidelines for Phase I inspections, and additional guidance provided by the New England Division, Corps of Engineers. The Probable Maximum Flood (PMF) was estimated from guide curves for probable maximum flood for New England region, based on past Corps' studies. The PMF peak versus drainage area curves are presented in the section of hydrologic computations.

The PMF curve applicable for rolling areas was adopted for the estimation of PMF peak of the reservoir. The PMF peak discharge per square mile versus drainage area relationship can be expressed mathematically as follows:

$$Q = 2323 - 676.99 \, Log_{10} A$$

$$Qp = Q \times A$$

where:

Q = Unit peak discharge in cfs/square miles

Qp = Peak PMF discharge, in cfs, for the watershed of the dam

A = Watershed area, in square miles, upstream of the dam axis.

The computed peak discharges of PMF and one half of the PMF for a drainage area of 58 square miles using the above equation are 65,500 cfs and 32,750 cfs, respectively. A triangular shaped flood hydrograph was assumed for the inflow design hydrograph.

Both the PMF and one half the PMF inflow hydrographs were routed through the reservoir by the modified Puls Methods, utilizing computer program HEC-1. The peak outflow discharges for the PMF and one half of the PMF are 5,303 cfs and 990 cfs, respectively. Both the PMF and one half of the PMF when routed through the reservoir does not result in overtopping of the dam. It is noted that the spillway section, with all stop planks removed would be capable of passing more than one half of the routed PMF. It is further noted that one inch of runoff is equivalent to a 5-inch rise in the lake and that the 1.75-foot normal freeboard represents about 4.2 inches of runoff or about 22 percent of the Probable Maximum Flood (PMF), the recommended test flood for this project.

The state-outflow relationship for the spillway was prepared from field notes, sketches and limited construction drawings, and the reservoir capacity curve was developed using dam inventory data and planimetered areas from 15 minute quadrangle topography maps. Reservoir storage capacity included surcharge levels exceeding top of dam and assumed that the dam remains intact during routing. However, in the routing computations, the discharge through outlet facilities was excluded assuming the outlet will remain closed during the occurrence of the PMF. The spillway rating curve and the reservoir capacity curve are presented in the section of hydrologic computations.

Since the spillway of the dam is incapable of passing the PMF and one half of the PMF without overtopping the dam, an assessment of downstream hazards due to flood wave that would result with dam failure was also estimated. The magnitude of the flood wave was estimated using generally accepted "rule of thumb" computational procedures established by

the New England Division of the Corps of Engineers, in combination with sound hydrological engineering judgement.

Computations relating to the flood routing of the dam break hydrograph for downstream areas are given in the section on hydrologic computations. The result of this computation shows that in the event of a hypothetical dam failure at the time the lake level is at the top of dam, a lake discharge of about 12,166 cfs would be released. Flood stages in the downstream channel reaches are given in the following table:

TABLE 1

Distance Downstream of Dam Axis (Miles)	Est. Flood Stages (Feet)
0	10.0
1.0 (Ashland)	12.3
2.0	15.6

The flood stages would affect the structural stability of those buildings in the downstream reach, whose foundations are below the hypothetical inundation level, and could cause large scale property damage and possible loss of lives.

b. Experience Data

As far as is known, the dam has been overtopped only once, on July 4, 1973.

c. Visual Observations

The inundated river channel upstream of the dam is relatively narrow and shallow. The main part of Little Squam Lake appears to be very much deeper. A considerable amount of the lake storage in inactive. The maximum drawdown possible is not determinable without a detailed survey of the stream channel at the lake outlet.

d. Overtopping Potential

As indicated in Section 5.1.a., both the PMF and one half of the PMF when routed through Squam Lake Reservoir, result in overtopping of the dam. The spillway and reservoir surcharge capacitites are too small to accommodate the PMF and one half of the PMF flows. The PMF and one half of the PMF would overtop the dam by 5.8 and 3.10 ft. respectively. The spillway, with the stop logs in place to the normal pool level (Elev. 563), is capable of passing a flood equal to 22 percent of the PMF without overtopping the dam. However, with all stop logs removed, the spillway is capable of passing more than one half of the Spillway Design Flood (SDF).

Since the PMF is the SDF for this dam, according to the Recommended Guidelines for Inspection of Dams by the Corps, the spillway capacity of the Squam Lake Dam is considered inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

Based on a visual inspection, and in view of past performance, the structure appears stable. Seepage conditions reported in 1967 appear to have been corrected by the reconstruction of 1968.

b. Design and Construction Data

No design or construction data was available for the original dam, believed to be constructed in 1856. The dam was reconstructed in 1928 and plans for the reconstruction are available but shed no light on the original section which, in part, still remains. The extent of the foundation data is also insufficient to provide a basis for stability calculations.

No design calculations were recovered in connection with the 1927 reconstruction bearing on the stability of the spillway section such as loading cases, uplifts assumed under the base slab, seepage path calculations or foundation properties.

No design calculations were recovered in connection with the 1968 reconstruction which corrected a potentially serious sink hole type piping failure. No calculations of seepage paths or stability analyses were available for review pertaining to the engineering basis of the repairs carried out.

c. Operating Records

Review of available operating records show that it has been possible to regulate the level of Squam Lake so that the targeted maximum elevation

of 563.0 MSL is rarely exceeded. The maximum lake levels, except for one occasion, did not exceed 563.3 or 1.45 feet below the top of dam. On July 4, 1973, a maximum lake level at Holderness of Elevation 565 was recorded and the dam was overtopped by approximately 3 inches of water. The dam as presently modified, has remained stable under these hydraulic loadings over the past ten years.

d. Post Construction Changes

The dam as originally built in 1856 has been modified extensively. In 1927, heavy rains resulted in the failure of the original dam, and it was reconstructed the same year. At that time, the entire spillway section was reconstructed with concrete. An interlocking steel sheet piling cutoff was driven as near the upstream face of the dam as possible and capped with concrete. The 1927 reconstruction is considered to have increased the stability of the dam by the construction of an upstream sheet pile cutoff and increasing spillway and low level outlet capacity.

In 1967, a small cave-in occurred in the left abutment. The extent was described as a 6-foot diameter hole 4 feet deep with a water level equal to that of the impoundment. Upon attempts to drain the hole, inflow was estimated at about 50 gpm. The description of the failure indicates that it was probably caused by piping action and a short seepage path. No signs of the cave-in were readily apparent at the time of the inspection, because of additional fill placements in this area.

The 1968 reconstruction is considered to have increased the stability of the dam inasmuch as it resurfaced the water side of the left abutment masonry wall, preventing the short-circuiting of the seepage path. Additional fill was placed in the abutment area also increasing the seepage path sufficiently to prevent a recurrence of this type of a failure for the past 10 years.

e. Seismic Stability

The dam is located in Seismic Zone 2 and, in accordance with the Recommended Guidelines for Phase I, does not warrant seismic analyses.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

The overall physical condition of Squam Lake Dam is fair to good in spite of its long history of failures, and accidents. At present the dam is owned by the State of New Hampshire and is under the control of an experienced dam operating agency.

The dam has an inadequate spillway capacity, capable of passing 22 percent of the Spillway Design Flood (SDF) which in the case of this dam is the Probable Maximum Flood (PMF). The spillway discharge capacity has been estimated by current Corps of Engineers screening criteria, and the owner should determine the spillway capacity by more sophisticated and accurate methods and procedures. The discharge capacity of the normally used low level outlets and spillway could be affected by tailwater conditions in the downstream reach and should be calibrated for such conditions.

b. Adequacy of Information

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Urgency

The urgency of performing the recommendations and remedial measures are detailed below.

d. Need for Additional Investigations

There is no need for further investigations in this phase of the program. Recommended investigations to be carried out by the owner are listed below.

7.2 Recommendations

It is recommended that the owner, within 12 months after receipt of this Phase I Report, assemble the following information if the data can be found:

a. Data Acquisition

(1) An updated as-built set of drawings of the dam showing all pertinent details and correcting inadequacies and omission on the presently available drawings.

(2) Additional topographic surveys should be made in the channel reach of the river leading out of Little Squam and the channel connecting Little Squam Lake with Squam Lake in order to determine to the maximum drawdown possible in case of dam accident or failure.

(3) The extent of erodible materials in the critical channel reaches should also be determined.

(4) The topographic survey should also include detailed contour information in the vicinity of both abutments to permit evaluation of seepage paths.

b. Investigations

Determine the spillway capacity of the dam using more sophisticated and accurate methods than were used in the Phase I screening methodology employed in this report, including the routing of the inflow through the lake. A spillway discharge taking curve should be established utilizing accurate spillway crest, top of dam and abutment elevations and dimensions. A tailwater rating curve should be established based on the available U.S.G.S. rating curve for the gage downstream and extending it for the PMF range outflows expected. Spillway and outlet rating curves should be adjusted for possible effects to submergence.

Based on the results of the spillway capacity analyses, the owner should formulate plans for augmenting the spillway capacity, if shown necessary.

7.3 Remedial Measures

a. Alternatives

The alternatives for increasing the spillway capacity of the dam are:

(1) Improving the right abutment non-overflow section to safely pass additional flood discharges including downstream toe protection.

(2) Rehabilitation of the 66-inch diameter penstock on the right non-overflow section to serve as an additional outlet including energy dissipation provisions downstream.

(3) Addition of an auxiliary spillway on the left abutment.

(4) Lowering the lake levels seasonally to provide additional storage.

(5) A combination of the above alternatives.

b. O&M Maintenance and Procedures

The owner should initiate the following programs:

(1) A bi-annual inspection of the dam utilizing a visual check list similar to that used in this inspection report.

(2) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

(3) Assemble and keep on hand complete documentation of the dam design, as-built drawings, and any other data pertaining to the dam safety.

(4) Based on the investigations above, determine the future use of the 66-inch diameter penstock and make provisions for its permanent closure in the event it has no utility as a low level outlet.

(5) Clear the area downstream of the right abutment non-overflow section of trees and shrubs for a distance of 50 feet.

(6) The owner should establish a formal system with local officials for warning downstream residents in case of emergency. Round the clock surveillance should be provided by the owner during periods of unusually heavy precipitation.

APPENDIX A

CHECK LISTS
- VISUAL OBSERVATIONS
- ENGINEERING, CONSTRUCTION MAINTENANCE DATA
- HYDRAULIC AND HYDROLOGIC DATA ENGINEERING DATA

CHECK LIST
VISUAL INSPECTION
PHASE 1

Name Dam SQUAM LAKE DAM County Grafton State New Hampshire Coordinators

Date(s) Inspection June 5, 1978 June 6, 1978 Weather Fair Temperature 65°F

Pool Elevation at Time of Inspection 562.7 M.S.L. Tailwater at Time of Inspection 551.7 M.S.L.

Inspection Personnel:

Seymour Roth, June 6
David Kerkes, June 6
Yin Au-Yeung, June 6
Recorder: Seymour M. Roth

William Flynn, June 5
Lynn Brown, June 5

Representing the N.H. Water Resources Board on June 5, 1978:

Mr. Lyall Milligan, Dam Operator

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEEPAGE OR LEAKAGE	No leakage or seepage was observed.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	On the right abutment, the existing gravity wall has been raised 18 in.± by the addition of a concrete parapet which runs into the hillside. On the left abutment, the existing masonry has been capped with new concrete walls, parapets and a concrete cutoff wall running up to River Road. Condition of junction considered good.	
DRAINS	No drains were visible.	
WATER PASSAGES	Three 4.0 ft. wide x 4.5 ft. high bottom outlets are built into the overflow section. Controls are timber gates, hoist operated. A 66-inch diameter old penstock on the right abutment is in a closed position and not used. A 30-in. diameter penstock passes through the left non-overflow section. The pipe is squashed downstream.	Permanently plug 66-inch diameter abandoned penstock.
FOUNDATIONS	Apparently built on alluvial sands and gravel occurring in the bed of the Squam River.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	No major cracking was observed in the new concrete work dating to 1964. There is some minor spalling in the right abutment parapet near the 66-inch abandoned penstock. The overflow section concrete is weathered and surface deteriorated but in acceptable condition.	
STRUCTURAL CRACKING	None observed.	
VERTICAL & HORIZONTAL ALIGNMENT	All surfaces have been reconstructed. Alignments and levels levels look good.	
MONOLITH JOINTS	No monolith joints were observable.	
CONSTRUCTION JOINTS	The construction joints observed in the new concrete facing were acceptable in alignment. The left abutment training wall is constructed of trimmed stones laid up without mortar The condition is acceptable. The right abutment has trimmed masonry construction, the face is cement pointed. Some stones are missing at the right training wall.	

ABUTMENT AREAS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The right abutment has been backfilled to the top of the non-overflow section. The left abutment has been backfilled to a level 26 in. above the nominal height of the non-overflow parts of the dam.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Not applicable.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Not applicable.	
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	Not applicable.	
RIPRAP FAILURES	Not applicable.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Not applicable	
ANY NOTICEABLE SEEPAGE	Not applicable	
STAFF GAGE AND RECORDER	Not applicable	
DRAINS	Not applicable	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet passages are under the prevailing tailwater level and could not be inspected. The concrete adjacent to the outlets was surface deteriorated due to erosive action of water and freeze-thaw effects.	Inspect outlet passages at opportune tine when the lake level and outflows are low.
INTAKE STRUCTURE	A fish screen structure has been built in front of the spillway and low level outlets.	
OUTLET STRUCTURE	See comments under "Water Passages - Concrete Masonry Dam".	
OUTLET CHANNEL	The outlet channel is protected by a short apron slab extending downstream of the low level outlet openings. The slab could not be inspected due to high tailwater levels.	Inspect downstream apron slab in the dry during low water conditions. Check for undercutting and channel degradation.
EMERGENCY GATE	No emergency gates have been provided. The three 4 ft. wide x 4 ft.-6 in. passages are closed by service sluice gates constructed of timber. The gates are hoist operated.	No action required.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	The concrete weir is divided into four sections each approx. 5-ft. wide. The spillway crest is surmounted by stop planks. The concrete divider piers are eroded by freeze-thaw action, as is the surface of the weir. The stop planks were in acceptable condition.	No action required at this time.
APPROACH CHANNEL	The approach channel is the submerged reach of Squam River leading from Squam Lake. A short concrete apron upstream of the low level outlets and the spillover weir could not be inspected due to headwater levels.	
DISCHARGE CHANNEL	A short concrete apron downstream of the spillway weir could not be inspected due to tailwater conditions.	
BRIDGE AND PIERS	A new concrete walkway has been built on the spillway piers. The concrete is in good condition.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES & OPERATION EQUIPMENT	Not applicable.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/ SURVEYS		
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER	A U.S.G.S. gaging weir and recorder are located 300 ft. dowsntream of the dam axis. A lake level float gage is located in the channel connecting Squam Lake and Little Squam Lake. The lake level data is telephonically transmitted to NH-WRB headquarters in Concord, N.H.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENTATIONS
SLOPES	Reservoir slopes in the reach between the dam and Little Squam Lake are gentle and covered with vegetation. Rim slopes are 1 on 4 horizontally for the first 5 ft. above the reservoir level, slightly steeper above that point.	
SEDIMENTATION	No sedimentation was visible in the approach channel reach of the Squam River between the dam and the main lake.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The channel is well defined and unobstructed in the reach downstream of the dam. River Road crosses the river 500 ft. downstream of the dam.	
SLOPES	The stream bank slopes are 1 on 2 horizontal and approximately 10 to 12 feet high in the immediate reach downstream of the dam.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Ashland is 0.8 of mile downstream of the dam axis. This area is heavily propulated, with approximately 1,400 residents.	

CHECK LIST

ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available for reconstruction of 1967, and partially for work done in 1964.
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	A brief account of the 1927 reconstruction is in the files of the N.H. Water Resources Board.
TYPICAL SECTIONS OF DAM	Available for 1927 reconstruction; not available for repairs made in 1964.
HYDROLOGIC/HYDRAULIC DATA	Some calculations of inflow and spillway and outlet capacity have been made in 1928, but are not correlated to U.S.G.S. datum plans.
OUTLETS - PLAN	Available for 1927 reconstruction
- DETAILS	
- CONSTRAINTS	Not available
- DISCHARGE RATINGS	
RAINFALL / RESERVOIR RECORDS	Summary of lake levels and precipitation are available for years 1941-1965. Squam River discharge records (USGS gage 01077000 - Squam River at Ashland) available for year 1940-present.

ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	*None available*
BORROW SOURCES	Unknown
SPILLWAY PLAN - SECTIONS - DETAILS	Available as built in 1927

ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	Available as built in 1927
MONITORING SYSTEMS	None
MODIFICATIONS	Existing structure built in 1846, rebuilt in 1902, 1927 and 1968.
HIGH POOL RECORDS	Available for period 1941-1964 in summary form.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Brief accounts of construction accomplished in 1927 is available.
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	The dam in its previous form failed in 1902 and 1927. A serious leak developed behind the left abutment training wall in 1967.
MAINTENANCE OPERATION RECORDS	None available from N.H. Water Resources Board.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: SQUAM LAKE DAM

Drainage Area Characteristics: 58 square miles

Elevation Top Normal Pool (Storage Capacity): 563 (39,600 AF)

Elevation Top Flood Control Pool (Storage Capacity): NA

Elevation Maximum Design Pool: 563

Elevation Top Dam: 564.75

SPILLWAY CREST:

a. Elevation Fixed crest at 557.8 (estimated)
b. Type Ogee section surmounted by stop logs
c. Width NA
d. Length 22 feet
e. Location Spillover At center of dam
f. No. and Type of Gates Not applicable

OUTLET WORK:

a. Type 3 openings,4ft.-0 in. wide x 4 ft.-6 in. high
b. Location At spillway section
c. Entrance Inverts 548.3 (estimated)
d. Exit Inverts 548.3 (estimated)
e. Emergency Draindown Facilities Sluice openings as above

HYDROMETEOROLOGICAL GAGES:

a. Type Automatic water level recorder and gaging weir
b. Location 300 feet downstream of dam
c. Records 1940-1975

MAXIMUM NON-DAMAGING DISCHARGE 1,436 cfs (estimated)

APPENDIX B

PHOTOGRAPHS

All Photographs taken on June 5, 1978

Photo 1 - View of the dam taken from the left abutment, looking toward the right abutment. The spillway section is in the foreground, showing the sluice gate hoists and the stems of sluice gates. The right abutment non-overflow section is in the foreground.

Photo 2 - View of the right abutment non-overflow section from downstream. The original masonry wall is visible in front and the new concrete parapet wall is in the background. The 66-in. diameter abandoned penstock and its gate hoist are visible at the picture's right.

Photo 3 - View of the dam from the right abutment showing old and new non-overflow sections and the relation to the spillway walkway elevation.

Photo 4 - View of the dam from the left abutment looking along the line of the cutoff wall which is visible in the foreground. The cutoff wall has been backfilled on the downstream side.

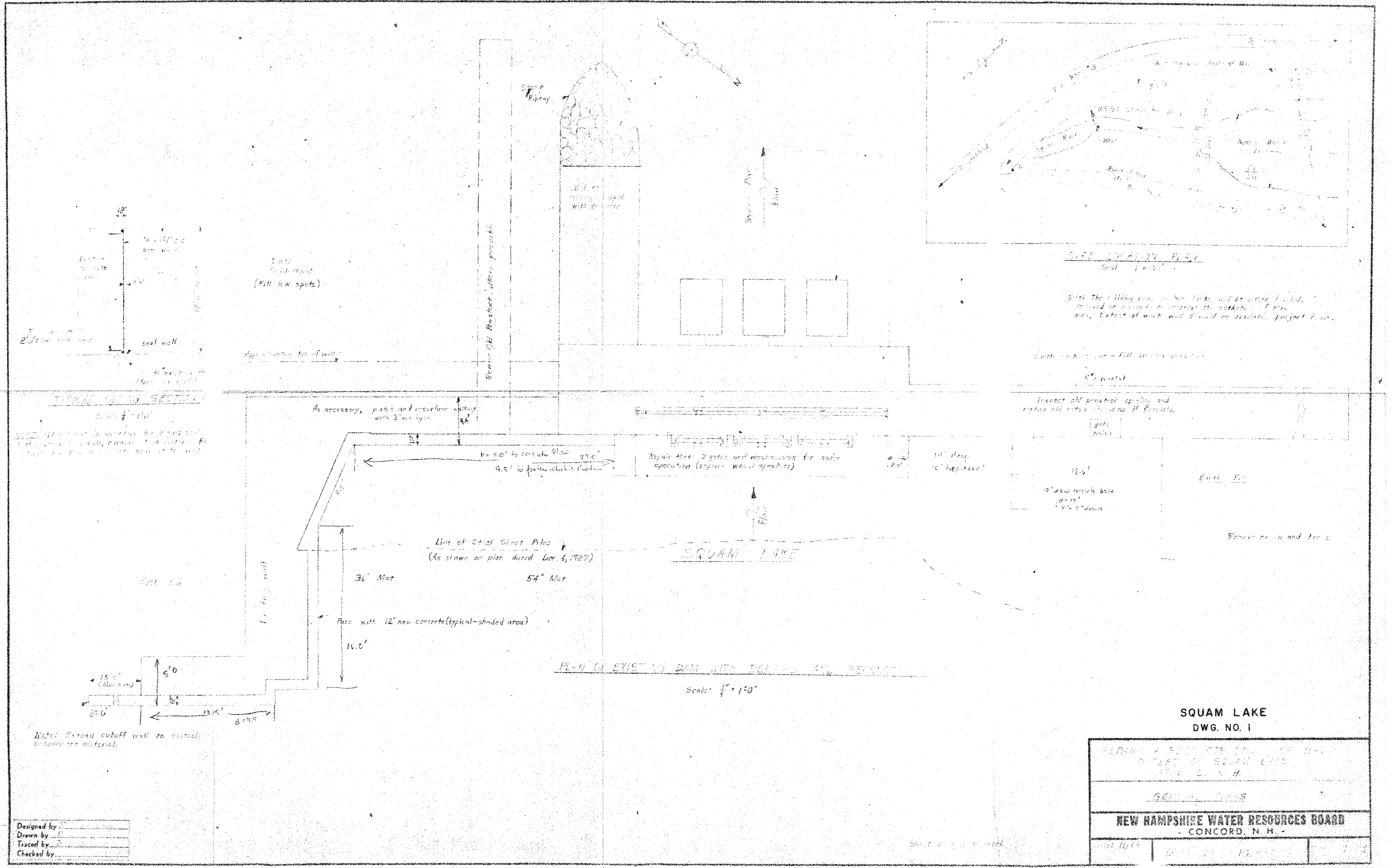
Photo 5 - View of the downstream channel of Squam River taken from the dam.

Photo 6 - View of the approach channel section of Squam Lake.

APPENDIX C

PLATES

PLANS & DETAILS OF DAM	Drawings 1,2,3 & 4
GEOLOGICAL MAP	Drawing 5


(Fill low spots)
As necessary, patch and resurface walkway with 3" min. layer
Line of Steel Sheet Piles
(As shown on plan dated Dec. 6, 1927)
SQUAM LAKE
36" Mat
54" Mat
Face with 12" new concrete (typical-shaded area)
16.0'
5'0
Earth Fill
Scale: 1/8" = 1'-0"
Note: Extend cutoff wall to suitable impervious material.
SQUAM LAKE
DWG. NO. 1
NEW HAMPSHIRE WATER RESOURCES BOARD
- CONCORD, N.H. -
Designed by
Drawn by
Traced by
Checked by
REVISIONS
DATE

OLD STONE MASONRY CAPED WITH CONCRETE

LINE OF MILL

NEW DAM SECTION

El. 4.50

OLD CONCRETE

El. 16.50

5'-0"

10'-0"

El. 16.50

El. 4.50

B.D. WALL

36" MAT

LINE OF MILL

El. 10.50

El. 1.00

18'-0"

El. 16.50

Line of Steel Sheet Piles

El. 9.50

54" MAT

2'-0"

3'-0"

El. 2.75

10'-6"

12'-0"

33" MAT

7'-0"

El. 16.50

6"

22'-10"

SQUAM LAKE

DWG. NO. 2

-1627-

NHPSC

I-1969 CASE

— DOCKET

D-1410 (5) PLAN

PLAN SHOWING ADDITIONAL CONCRETE AND PILING & ELEV.

ASHLAND DAM

TOWN OF ASHLAND

N.H.

Made by H.A. SLEEPER Dec. 6 1928

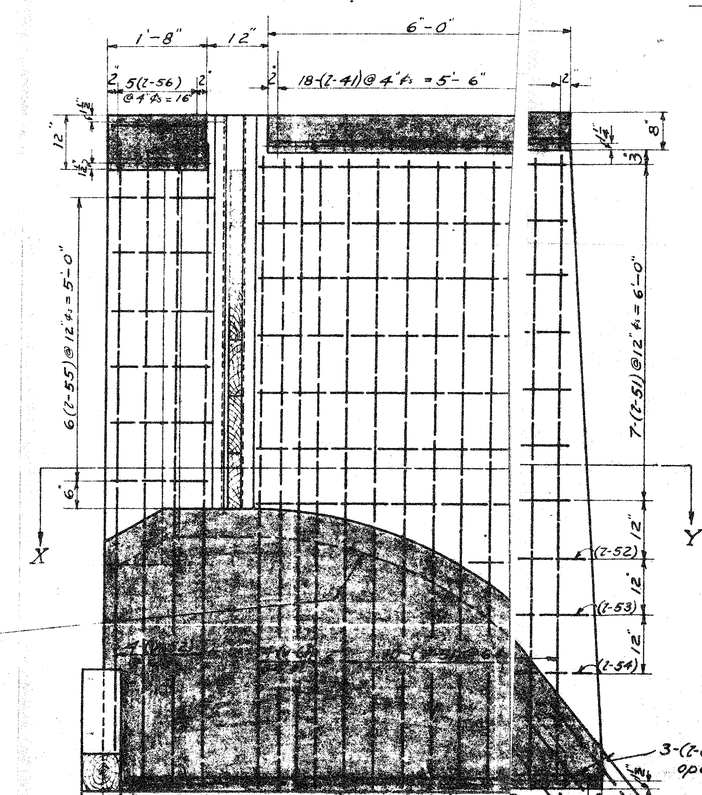
Traced by N.E.Y.

Checked by

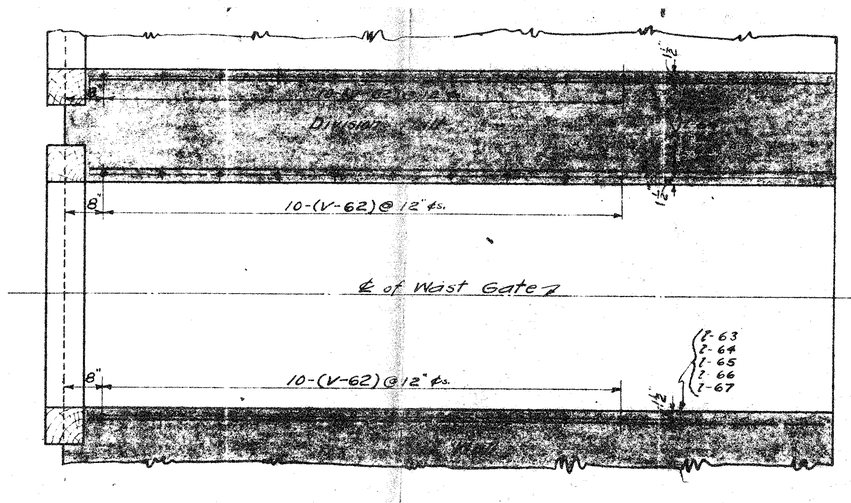
Scale 1"=1'-0"

Date Jan. 6 1928

J.W. JONES & CO ENGINEERS MILTON N.



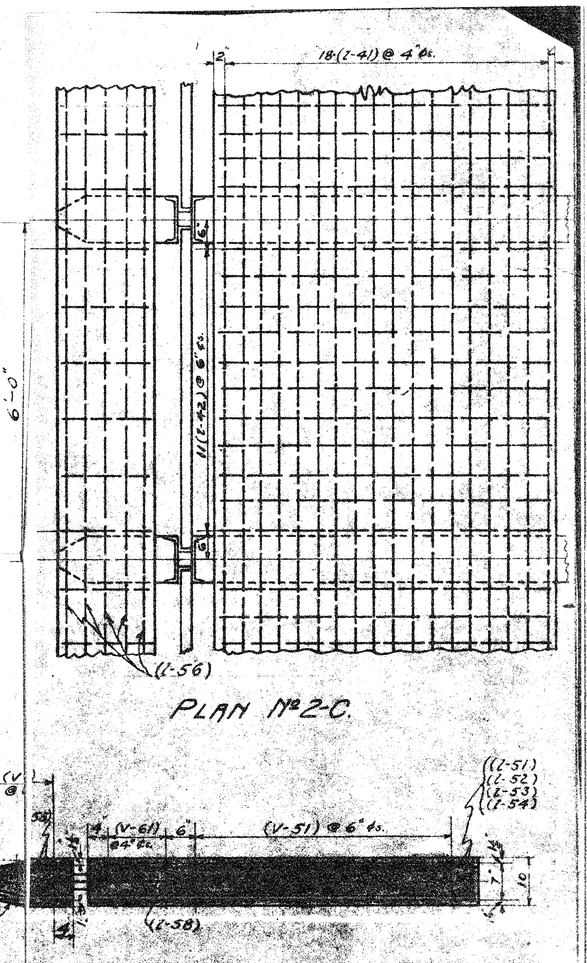
SECTION Nº1-C.



SECTION Nº4-C ON LINE M-N.

List of Reinforcing Steel.

Nº of Bars	Symbol	Length	Shown on Drawing	Location
		½" dia. Bars		
36	I-41	15'-0"	N4-C · N2-C	Platform back of Flashboards
44	I-42	5'-8"	" "	" " "
		⅝" dia. Bars		
42	I-51	6'-0"	N1-C N3-C	Flashboard Division Walls
6	I-52	3'-0"	" "	" " "
6	I-53	1'-6"	" "	" " "
6	I-54	1'-6"	" "	" " "
36	I-55	1'-8"	" "	" " "
20	I-56	15'-0"	N1-C N2-C	Slab Supporting Gate Hoist
48	I-57	1'-6"	" "	" " "
60	V-51	11'-6"	N4-C N2-C	Flashboard Division Walls.
24	V-52	11'-6"	" "	" " "
		¾" dia. Bars		
30	I-61	6'-0"	N1-C	over wast Gate openings
9	I-62	8'-10"	"	" " "
6	I-63	9'-6"	N4-C N2-C	Sides of wast Gate opening
6	I-64	10'-0"	" "	" " " "
6	I-65	11'-0"	" "	" " " "
6	I-66	12'-0"	" "	" " " "
6	I-67	14'-0"	" "	" " " "
24	V-61	11'-6"	N4-C N3-C	Flashboard Division Walls
60	V-62	8'-0"	N2-C N2-C	Sides of wast Gate openings
18	V-63	9'-0"	" "	" " " "
		½" dia. Bars		
12	I-43	8'-6"		End Facing
12	V-41	9'-0"		" "
		⅝" dia. Bars		
9	I-58	4'-0"	N3-C	Flashboard Division Walls



PLAN Nº2-C.

SECTION Nº3-C on LINE X-Y.

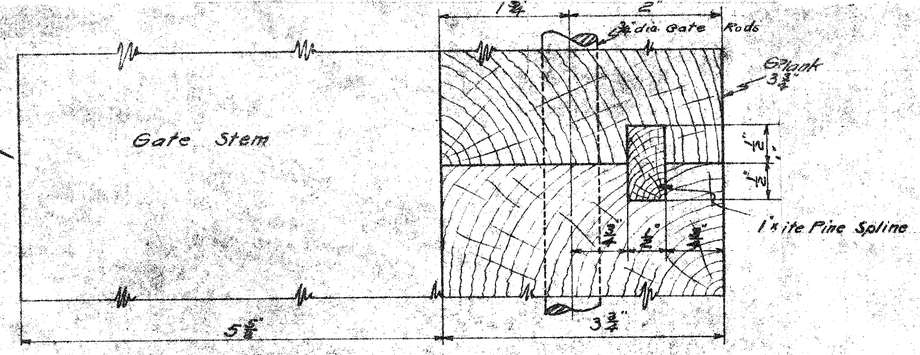
SQUAM LAKE
DWG. NO. 3.

NHPSC
I-1969 CASE
—
DOCKET
D-1410 (6) PLAN

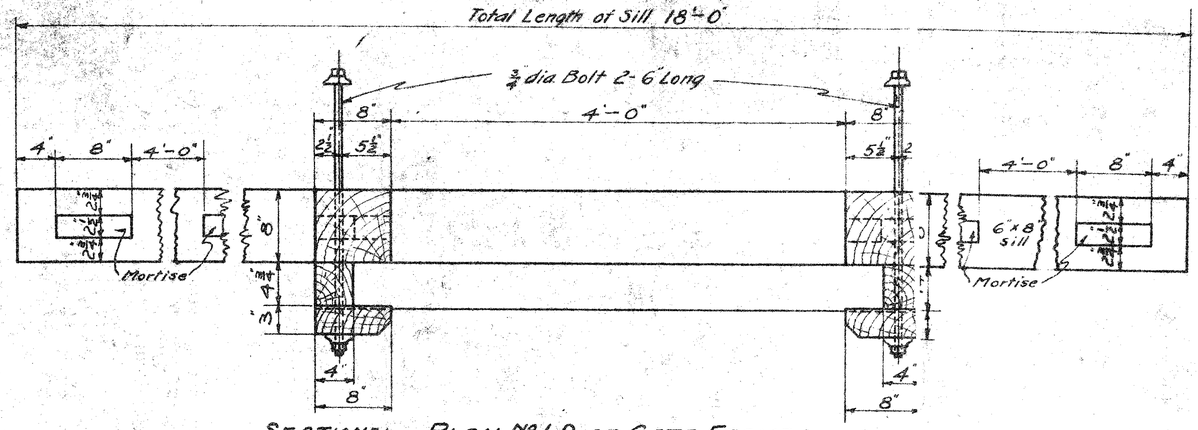
1627

Sheet C
DETAILS OF REINFORCING STEEL
REPAIRS TO DAM
ASHLAND, N.H.
TOWN OF ASHLAND, N.H.

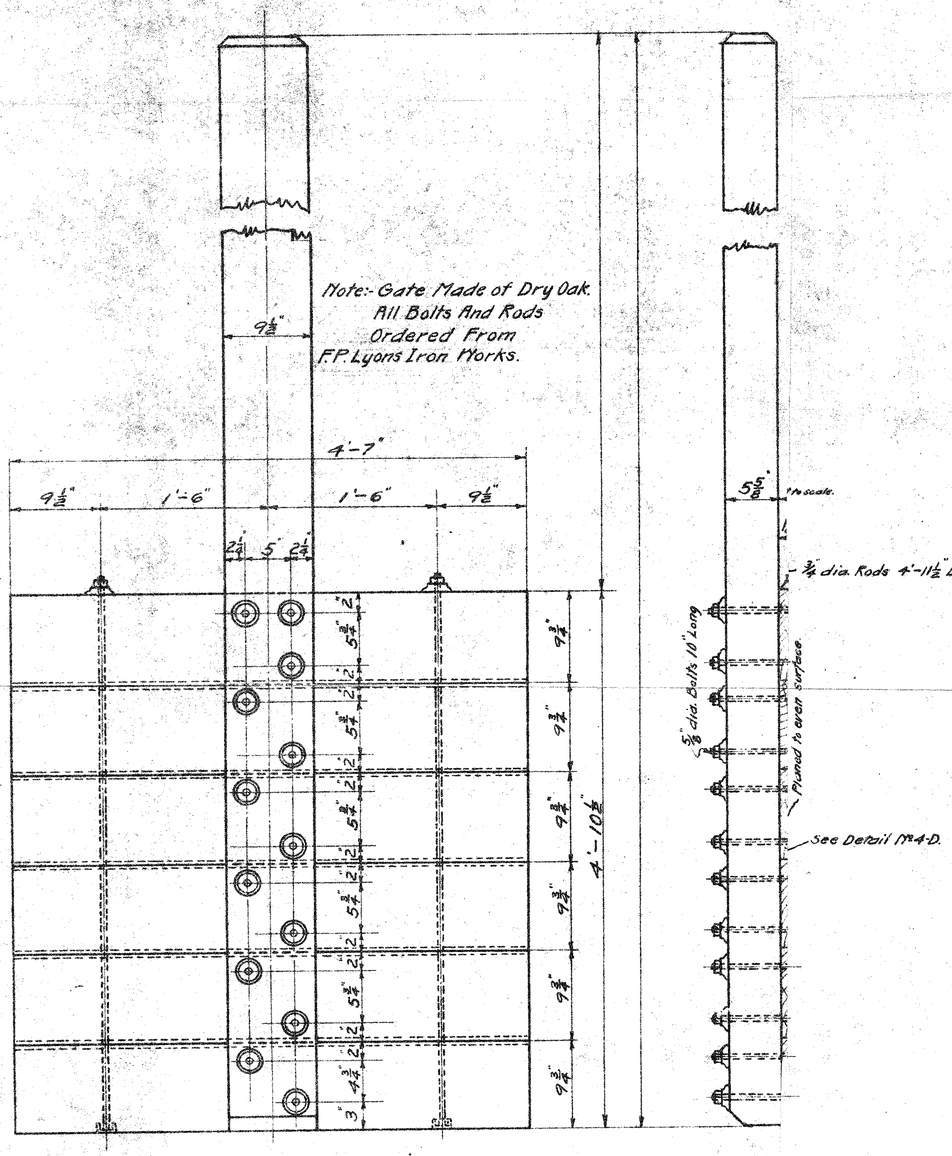
Made: W.L.S.
Traced: W.L.S.
Checked: H.M.B.
Scale: 3/4"=1'-0"
Feb. 21, 1927



DETAIL Nº 4-D OF SPLINES IN GATE PLANK.
Scale:- Full Size

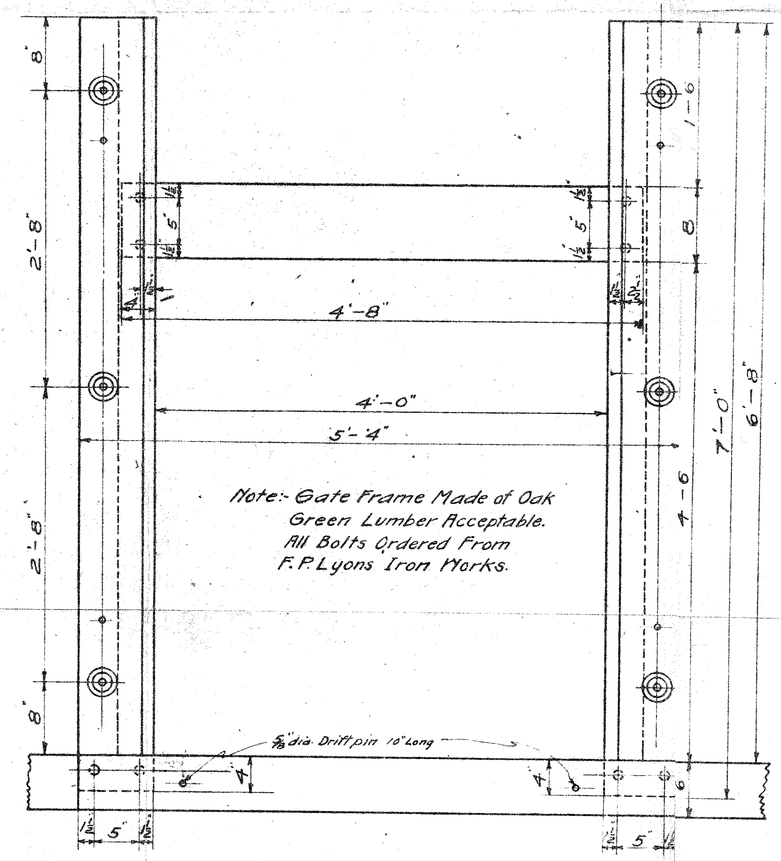


SECTIONAL PLAN Nº 1-D OF GATE FRAME.
Scale:- 1½"=1'-0"

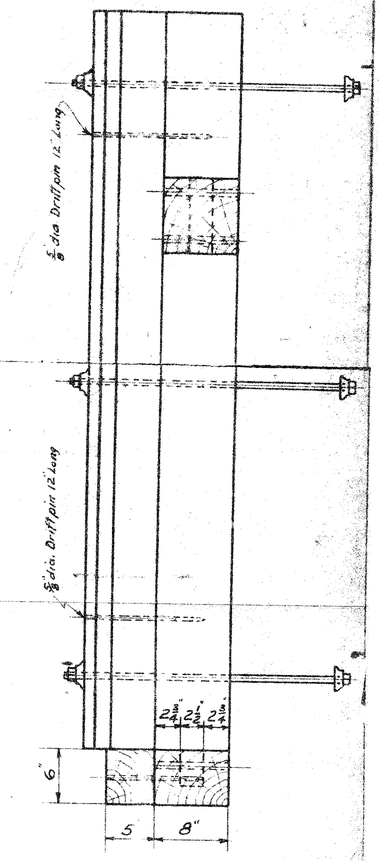


FRONT ELEVATION Nº 5-D OF GATE.
Scale:- 1½"=1'-0"

SECTION Nº 6-RU GATE.
Scale:- 1½"=1'-0"



FRONT ELEVATION Nº 2-D OF GATE FRAME.
Scale:- 1½"=1'-0"



SECTION Nº 3-D.
Scale:- 1½"=1'-0"

SQUAM LAKE
DWG. NO. 4

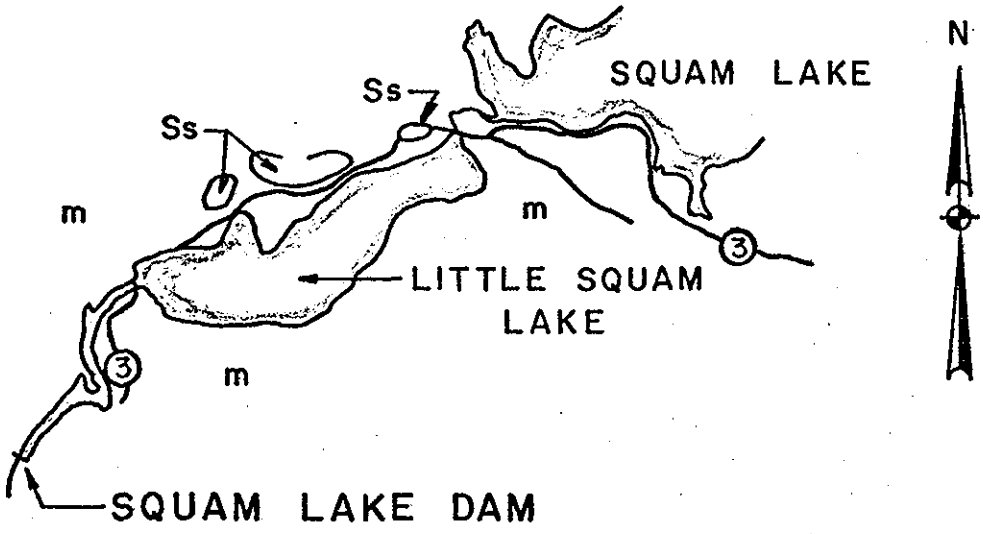
NHPSC
I-1969 CASE
—
DOCKET
D-1410 (E) PLAN

1627

Sheet D
DETAILS OF GATE & GATE FRAME.
REPAIRS TO DAM
ASHLAND, N.H.
TOWN OF ASHLAND
N.H.

Made:- W.L.S.
Traced:- W.L.S.
Scale:- 1½"=1'-0"
Sep. 24, 1927

F.W. JONES & CO.



1 0 1 2

Scale: 1" = 1 Mile

LEGEND:

m	Ground Moraine (Till)
Ss	Stratified Sandy Gravel Deposits in Kame Terraces or Valley Trains
——	Contact

NOTES:
1. Scattered Outcrops of Gneiss Occur on North Side of LaKe
2. Sand with Some Gravel in Stream Channel Below Dam

GEOLOGIC MAP
SQUAM LAKE DAM

DWG. NO. 5

APPENDIX D

HYDROLOGIC COMPUTATIONS

SQUAM LAKE DAM
DRAINAGE BASIN

Maximum Probable Flood Peak Flow Rate.

According to NED General Curve

Assume rolling area:

$Q = 2323 - 676.99 \log_{10} A$

$A = 58$ sq. mile.

$\therefore Q = 1129.2$ cfs/sq. mile.

$Q_p = A \times Q = 58 \times 1129.2 = 65,500$ cfs.

Since MPF runoff in New England equals approx 19 inches according to NED guideline.

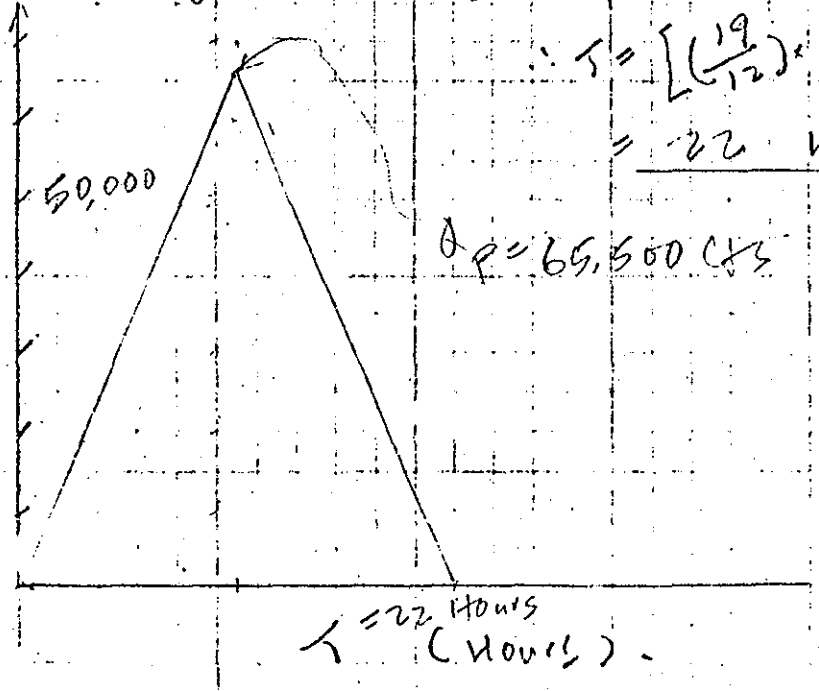
The triangular hydrograph will be approximate to the following shape:

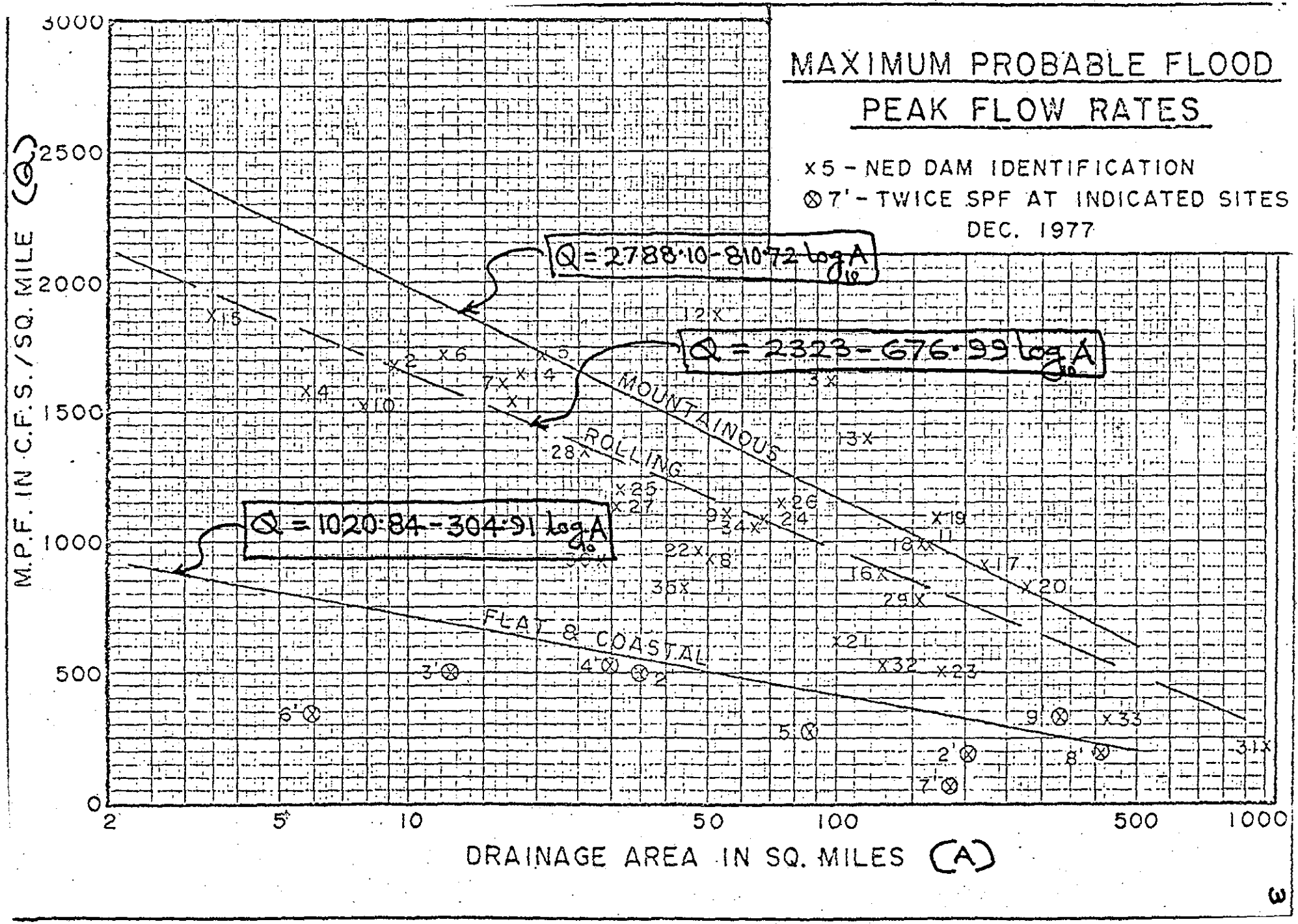
$\frac{1}{2} T \times Q_p = 19'' \times A$

$\therefore T = \left[\left(\frac{19}{12}\right) \times 58 \times 27,878,400\right] / 3600 \times 0$

$= 22$ hours

$Q_p = 65,500$ cfs




MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SITES
DEC. 1977
Q = 2788·10 - 810·72 log A
10
Q = 2323 - 676·99 log A
10
Q = 1020·84 - 304·91 log A
10
MOUNTAINOUS
ROLLING
FLAT & COASTAL
M.P.F. IN C.F.S./SQ. MILE (Q)
DRAINAGE AREA IN SQ. MILES (A)
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
1000

SQUAM LAKE DAM

EFFECTS OF FAILURE OF DAM

Step 1: Determine Peak Failure Outflow Q_{p_1}:

$$Q_{p_1} = \frac{8}{27} W_b \sqrt{2g}\, y_o^{3/2}$$

where

Q_{p_1} = Peak Failure outflow in cfs

W_b = 40% of dam length across river at midheight between the dream-bed and top of dam.

y_o = Total height from riverbed to top of dam.

$W_b = 0.40 \times (167' \pm) \simeq 67$ feet

$y_o = 18$ ft.

$$\therefore Q_{p_1} = \frac{8}{27}(67)\sqrt{64.4}\,(18)^{1.5}$$

$$= 12166 \text{ cfs}.$$

Step 2: Develop stage-discharge rating curves for the downstream channel, assuming uniform flow, Mannings 'n' = 0.10

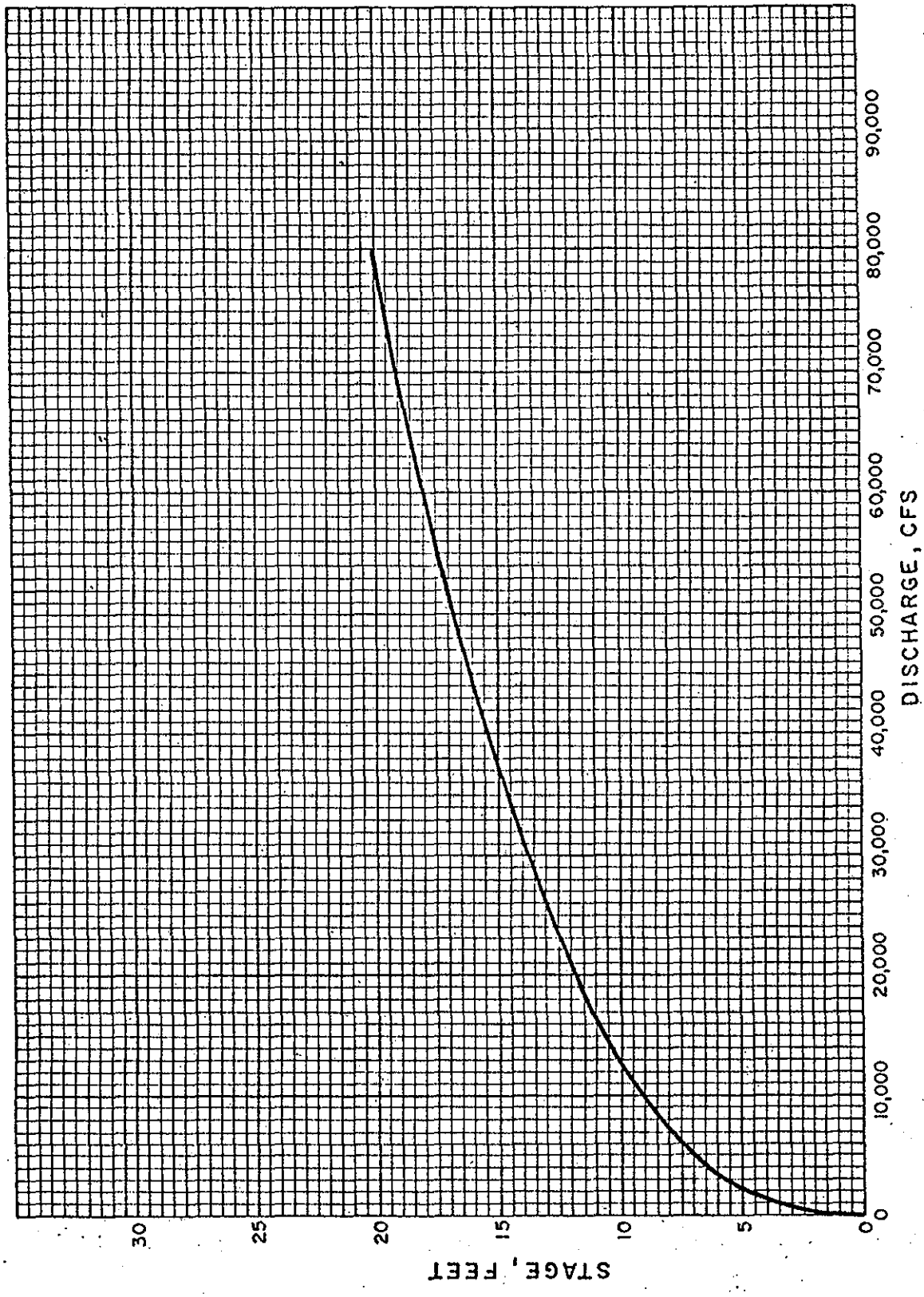
and using USGS topo maps for estimating cross-sections.

The stage-discharge curves for Squam River downstream from the Squam Lake Dam are on pages 3 through 5.

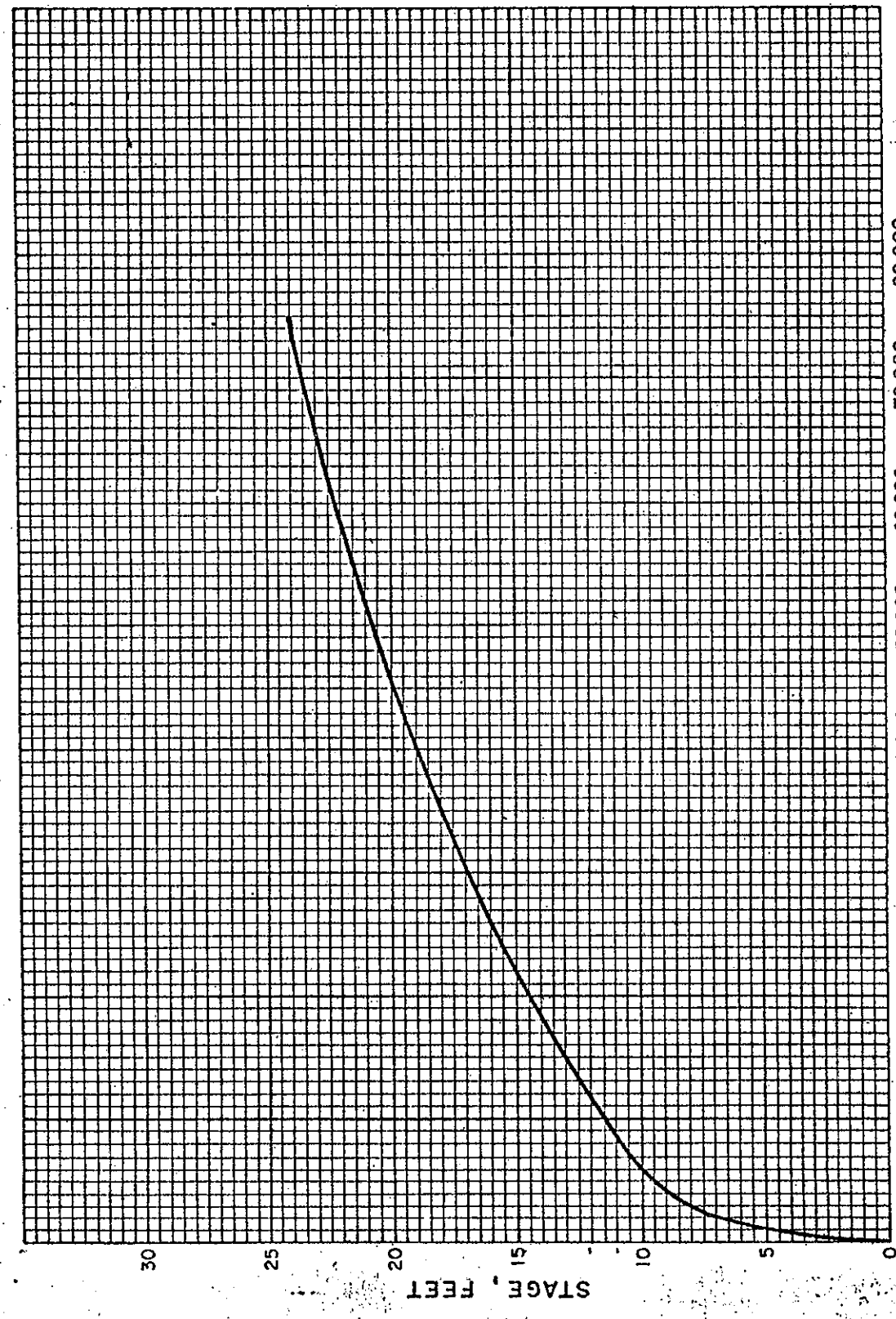
Step 3: Determine stage corresponding to Q_{p_1} at each section assuming the stage discharge curves are valid for unsteady non-uniform flow case (Rule of thumb).

Peak Discharge, $Q_{p_1} = 12{,}166$ cfs

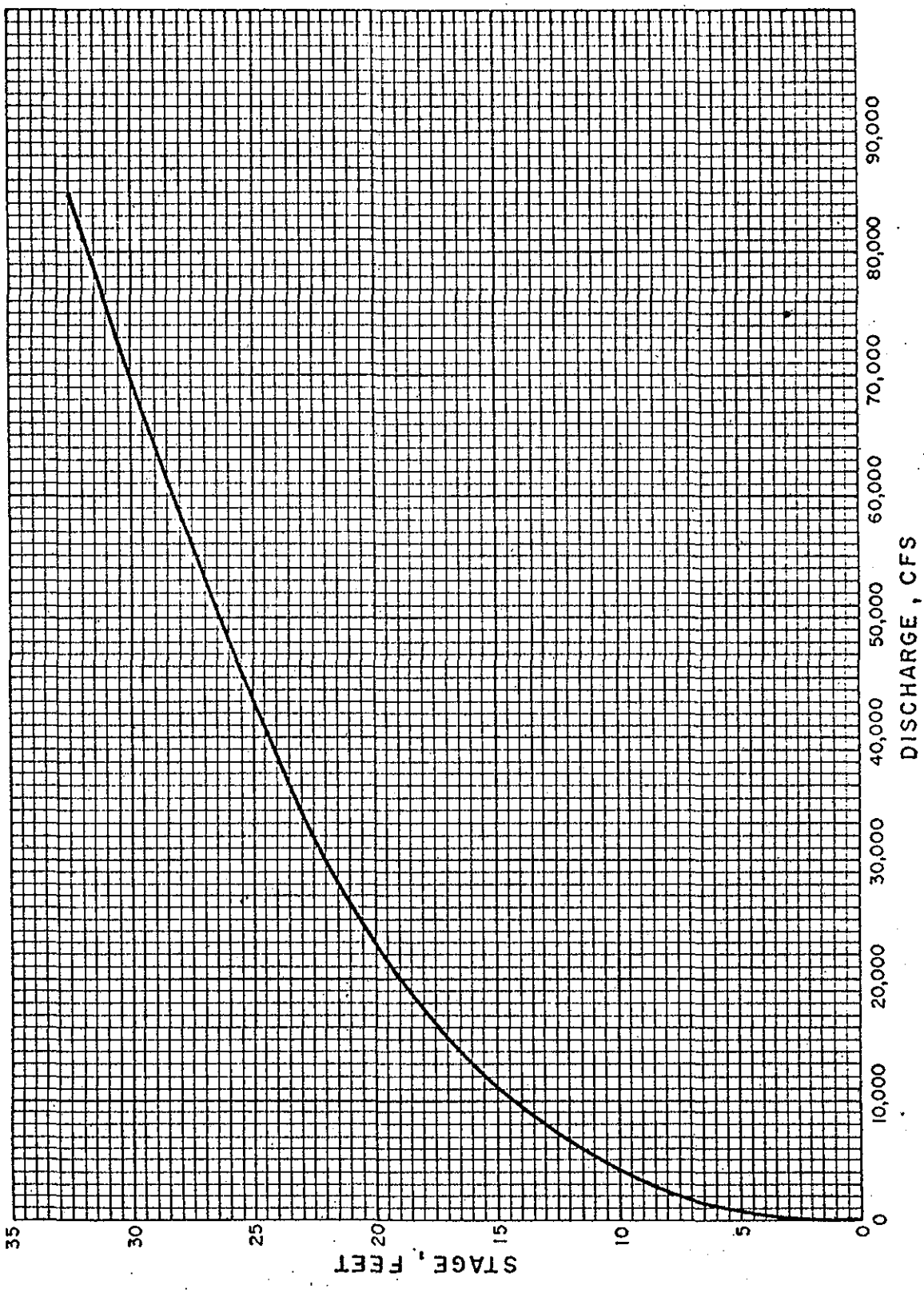
Distance from Dam, Miles	0	1	2
Stage, Feet	10	12.3	15.6



SQUAM RIVER
STAGE-DISCHARGE CURVE
JUST DOWNSTREAM FROM
SQUAM LAKE DAM



SQUAM RIVER
STAGE-DISCHARGE CURVE
ONE MILE DOWNSTREAM
FROM SQUAM LAKE DAM



SQUAM RIVER
STAGE-DISCHARGE CURVE
TWO MILES DOWNSTREAM
FROM SQUAM LAKE DAM

SQUAM LAKE DAM

RESERVOIR AREA - CAPACITY

Normal Storage = 39,600 AF at Normal Lake at Elev 563

Maximum Storage = 44,000 AF

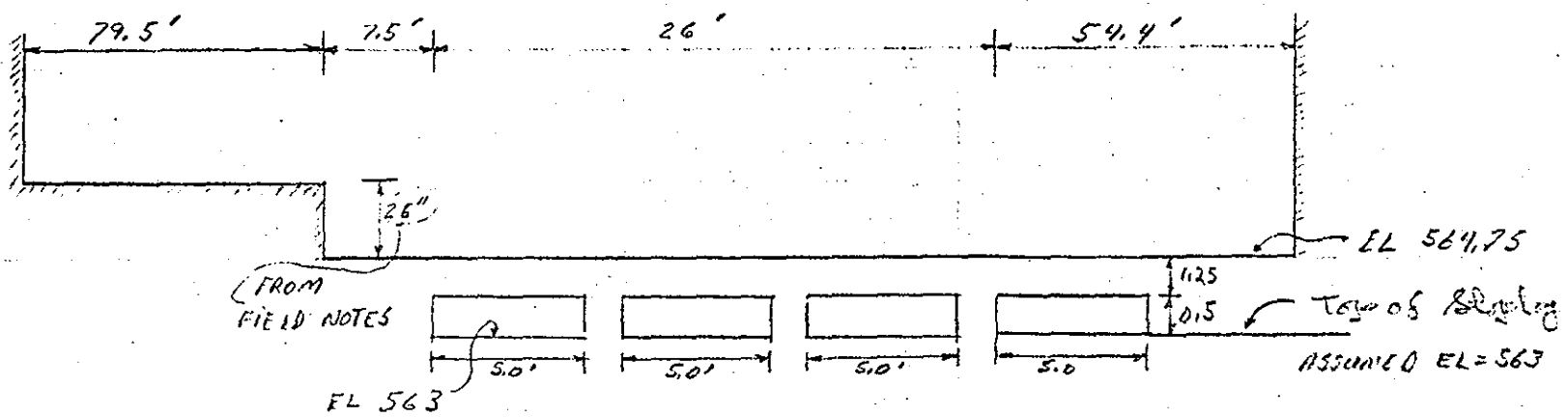
Elevation (MSL) Feet	Reservoir surface area (acres)	Incremental volume (AF)	Total Volume (AF)	Remarks
562	7450		32097	
563	7557	7504	39,600	Normal Pool.
564.75	7745	13389	52989	
580	9382	130,593	183,582	
590	10,455	99,185	282,767	

SQUAM LAKE DAM
RESERVOIR CAPACITY CURVE
ELEVATION, FEET
586
582
578
574
570
566
562
TOP OF DAM, EL 564.75
NORMAL POOL, EL 563
30,000
70,000
110,00
150000
190,000
230,000
270,000
310,000
315,000
RESERVOIR CAPACITY ACRE-FEET

NEW HAMPSHIRE DAM SAFETY INSPECTION SHEET NO. 1 OF ____

SQUAM LAKE DAM JOB NO. 1211-001-1

SPILLWAY AND OVERTOP RATING CURVE BY HLB DATE 9-13-7



ELEV (FT)	HEAD ON SPILLWAY CREST	H_1	H_2	H_3	L_1	L_2	L_3	C_1	C_2	C_3	$Q = 0.6A\sqrt{2gH}$	ΣQ
563	0.	0.										0
563.5	0.5	0.5			20			3.1				22
564	1.0	1.0						3.2			48	48
564.50	1.5	1.5						3.3			59	59
564.75	1.75	1.75	0.					3.35			64	64
565.0	2.0	2.0	0.25			87.9		3.4	3.03		68	101
566.0	3.0	3.0	1.25			87.9		3.6	3.03		83	455
566.92	3.92	3.92	2.17	0.		87.9		3.7	3.03		95	946
567.0	4.0	4.0	2.25	0.08		87.9	79.5	3.7	3.03	3.03	96	1000
568.0	5.0	5.0	3.25	1.08		87.9	79.5	3.8	3.03	3.03	108	1938
570.0	7.0	7.0	5.25	3.08		87.9	79.5	3.8	3.03	3.03	127	4633
572.0	9.0	9.0	7.25	5.08		87.9	79.5	3.8	3.03	3.03	144	8101
574.0	11.0	11.0	9.25	7.08		87.9	79.5	3.8	3.03	3.03	160	12191
578.0	15.0	15.0	13.25	11.08		87.9	79.5	3.8	3.03	3.03	191	21916

ELEV 563.5

$$Q = C_1 L_1 H_1^{3/2} = 3.1 \times 20 \times 0.5^{3/2} = \underline{22}$$

ELEV 564

$$Q = 0.6\, A \sqrt{2g H_1} = 0.6 \times (0.5 \times 5 \times 4) \times \sqrt{2 \times 32.2 \times 1} = \underline{48}$$

ELEV 564.5

$$Q = 0.6\, A \sqrt{2g H_1} = 48.15 \sqrt{H_1} = 48.15 \sqrt{1.5} = \underline{59}$$

ELEV 564.75

$$Q = 0.6\, A \sqrt{2g H_1} = 48.15 \sqrt{H_1} = 48.15 \sqrt{1.75} = \underline{64}$$

ELEV. 566.

$$Q = 0.6\, A \sqrt{2g H_1} + C_2 L_2 H_2^{3/2}$$

$$= 48.15 \sqrt{H_1} + 3.03 \times 87.9 \times 0.25^{3/2}$$

$$= 68 + 33 = \underline{101}$$

ELEV. 566

$$Q = 48.15 \sqrt{H_1} + C_2 L_2 H_2^{3/2}$$

$$= 48.15 \sqrt{3} + 3.03 \times 87.9 \times 1.25^{3/2}$$

$$83 + 372 = \underline{455}$$

ELEV. 566.92

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2}$$

$$= 48.15\sqrt{3.92} + 3.03 \times 87.9 \times 2.17^{3/2}$$

$$95 + 851 = 946$$

ELEV. 567.0

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2} + C_3 L_3 H_3^{3/2}$$

$$= 48.15\sqrt{4} + 3.03 \times 87.9 \times 2.25^{3/2} + 3.03 \times 79.5 \times 0.08^{3/2}$$

$$= 96 + 899 + 5. = 1000$$

ELEV 568

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2} + C_3 L_3 H_3^{3/2}$$

$$= 48.15\sqrt{5} + 3.03 \times 87.9 \times 3.25^{3/2} + 3.03 \times 79.5 \times 1.08^{3/2}$$

$$= 108 + 1560 + 270 = 1938$$

ELEV 570

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2} + C_3 L_3 H_3^{3/2}$$

$$= 48.15\sqrt{7} + 3.03 \times 87.9 \times 5.25^{3/2} + 3.03 \times 79.5 \times 3.08^{3/2}$$

$$= 127 + 3204 + 1302 = 4633$$

ELEV 572

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2} + C_3 L_3 H_3^{3/2}$$

$$= 48.15\sqrt{9} + 3.03 \times 87.9 \times 7.25^{3/2} + 3.03 \times 79.5 \times 5.08^{3/2}$$

$$= 144 + 5199 + 2758 = 8101$$

ELEV 574

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2} + C_3 L_3 H_3^{3/2}$$

$$= 48.15\sqrt{11} + 3.03 \times 87.9 \times 9.25^{3/2} + 3.03 \times 79.5 \times 7.08^{3/2}$$

$$= 160 + 7493 + 4538 = 12191$$

ELEV 578

$$Q = 48.15\sqrt{H_1} + C_2 L_2 H_2^{3/2} + C_3 L_3 H_3^{3/2}$$

$$= 48.15\sqrt{15} + 3.03 \times 87.9 \times 13.25^{3/2} + 3.03 \times 79.5 \times 11.08^{3/2}$$

$$= 186 + 12846 + 8884 = 21916$$

SQUAM LAKE DAM
SPILLWAY AND OVERTOP
RATING CURVE

HEC 1 - COMPUTATIONS

ENGINEERING CONSULTANTS, INC.

NEW HAMPSHIRE DAM SAFETY INSPECTION SHEET NO. 1 OF
SQUAM LAKE JOB NO. 1211-001-1
INPUT TO HEC-1 BY KLB DATE 9-14-7

INPUT TO HEC-1

#	ELEV (FT.)	HEAD ON SPILLWAY CREST (FT)	Y2 STORAGE (AC-FT)	Y3 DISCHARGE (CFS)
1	562.00	—	32097	0.
2	563.00 (NORMAL WATER SURFACE)	0.	39600	0.
3	564.00	1.0	47000.	48.
4	564.50	1.5	51000	59.
5	564.75 (TOP OF DAM)	1.75	52989	64.
6	565.00	2.0	55000	101.
7	565.50	2.50	59000	260.
8	566.00	3.00	63000	455.
9	568.00	5.00	79000	1938.
10	574.00	11.00	130000	12191

****
HEC-1 VERSION DATED JAN 1973
****

67.85
64.75
3.10

70.55
64.75
5.80

SQUAM LAKE
ROUTING STARTS AT 563

PMF	½ PMF	ROUTED PMF	ROUTED ½ PMF	OVERTOP HEIGHT PMF	OVERTOP HEIGHT ½ PMF	SPILLWAY CAPACITY
65500	32750	5303	990	5.80	3.10	64 CFS
						22%

****
HEC-1 VERSION DATED JAN 1973
****

DAM SAFETY INSPECTION - NEW HAMPSHIRE
SQUAM LAKE DAM - WITH STOPLOGS INPLACE TO ELEVATION 563
PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	30	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT TRIANGULAR SHAPED HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	58.00	0.00	58.00	0.00	0.000	0	0	0

INPUT HYDROGRAPH

0.	2977.	5955.	8392.	11909.	14886.	17864.	20841.	23818.	26795.
29773.	32750.	35727.	38705.	41682.	44659.	47636.	50614.	53591.	56568.
59545.	62523.	65500.	62523.	59545.	56568.	53591.	50614.	47636.	44659.
41682.	38705.	35727.	32750.	29733.	26795.	23818.	20841.	17864.	14886.
11909.	8932.	5955.	2997.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	65500.	56568.	30009.	10003.	1440440.
INCHES		9.07	19.25	19.25	19.25
AC-FT		28064.	59553.	59553.	59553.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THRU SQUAW LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	2	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	32097.	39600.	47000.	51000.	52989.	55000.	59000.	63000.	79000.	130000.
OUTFLOW=	0.	0.	48.	59.	64.	101.	260.	455.	1938.	12191.

TIME	EOP STOR	AVG IN	EOP OUT
1	39600.	0.	0.
2	39661.	1488.	0.
3	39846.	4466.	1.
4	40142.	7173.	3.
5	40561.	10150.	6.
6	41114.	13397.	9.
7	41790.	16375.	14.
8	42589.	19352.	19.
9	43511.	22329.	25.
10	44556.	25306.	32.
11	45723.	28284.	39.
12	47013.	31261.	48.
13	48426.	34238.	51.
14	49961.	37216.	56.
15	51620.	40193.	60.
16	53401.	43170.	71.
17	55304.	46147.	113.
18	57328.	49125.	193.
19	59471.	52102.	282.
20	61733.	55079.	393.
21	64112.	58056.	550.
22	66607.	61034.	789.
23	69214.	64011.	1031.
24	71812.	64011.	1271.
25	74276.	61034.	1500.
26	76609.	58056.	1716.
27	78810.	55079.	1920.
28	80875.	52102.	2315.
29	82802.	49125.	2702.
30	84589.	46147.	3061.
31	86240.	43170.	3393.
32	87754.	40193.	3698.
33	89134.	37216.	3976.
34	90379.	34238.	4225.
35	91491.	31241.	4449.
36	92471.	28264.	4646.
37	93321.	25306.	4817.
38	94041.	22329.	4962.
39	94634.	19352.	5081.
40	95098.	16375.	5174.
41	95437.	13397.	5242.
42	95650.	10420.	5285.
43	95739.	7443.	5303.
44	95705.	4476.	5296.
45	95548.	1498.	5264.
46	95332.	0.	5221.

47	95117.	0.	5178.
48	94904.	0.	5135.
49	94692.	0.	5092.
50	94483.	0.	5050.
51	94275.	0.	5008.
52	94069.	0.	4967.
53	93864.	0.	4926.
54	93662.	0.	4885.
55	93460.	0.	4845.
56	93261.	0.	4805.
57	93063.	0.	4765.
58	92867.	0.	4725.
59	92673.	0.	4686.
60	92480.	0.	4648.
61	92289.	0.	4609.
62	92099.	0.	4571.
63	91911.	0.	4533.
64	91724.	0.	4496.
65	91539.	0.	4458.
66	91356.	0.	4422.
67	91174.	0.	4385.
68	90993.	0.	4349.
69	90814.	0.	4313.
70	90637.	0.	4277.
71	90461.	0.	4242.
72	90286.	0.	4207.
73	90113.	0.	4172.
74	89941.	0.	4137.
75	89771.	0.	4103.
76	89602.	0.	4069.
77	89435.	0.	4035.
78	89268.	0.	4002.
79	89104.	0.	3969.
80	88940.	0.	3936.
81	88778.	0.	3903.
82	88618.	0.	3871.
83	88458.	0.	3839.
84	88300.	0.	3807.
85	88144.	0.	3776.
86	87988.	0.	3745.
87	87834.	0.	3714.
88	87681.	0.	3683.
89	87530.	0.	3652.
90	87379.	0.	3622.
91	87230.	0.	3592.
92	87082.	0.	3562.
93	86936.	0.	3533.
94	86790.	0.	3504.
95	86646.	0.	3475.
96	86503.	0.	3446.
97	86361.	0.	3418.
98	86221.	0.	3389.
99	86081.	0.	3361.
100	85943.	0.	3333.
101	85806.	0.	3306.
102	85670.	0.	3278.
103	85535.	0.	3251.
104	85401.	0.	3224.
105	85268.	0.	3198.
106	85136.	0.	3171.
107	85006.	0.	3145.

108	84876.	0.	3119.	
109	84748.	0.	3093.	
110	84621.	0.	3068.	
111	84495.	0.	3042.	
112	84369.	0.	3017.	
113	84245.	0.	2992.	
114	84122.	0.	2967.	
115	84000.	0.	2943.	
116	83879.	0.	2918.	
117	83759.	0.	2894.	
118	83639.	0.	2870.	
119	83521.	0.	2847.	
120	83404.	0.	2823.	
121	83288.	0.	2800.	
122	83173.	0.	2776.	
123	83058.	0.	2754.	
124	82945.	0.	2731.	
125	82833.	0.	2708.	
126	82721.	0.	2686.	
127	82611.	0.	2663.	
128	82501.	0.	2641.	
129	82392.	0.	2620.	
130	82285.	0.	2598.	
131	82178.	0.	2576.	
132	82072.	0.	2555.	
133	81966.	0.	2534.	
134	81862.	0.	2513.	
135	81759.	0.	2492.	
136	81656.	0.	2472.	
137	81554.	0.	2451.	
138	81453.	0.	2431.	
139	81353.	0.	2411.	
140	81254.	0.	2391.	
141	81156.	0.	2371.	
142	81058.	0.	2351.	
143	80961.	0.	2332.	
144	80865.	0.	2313.	
145	80770.	0.	2293.	
146	80676.	0.	2274.	
147	80582.	0.	2256.	
148	80489.	0.	2237.	
149	80397.	0.	2218.	
150	80306.	0.	2200.	
SUM			456417.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5303.	5193.	4644.	3169.	456417.
INCHES		0.83	2.97	6.09	6.10
AC-FT		2576.	9217.	18869.	18869.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	3	65500.	56568.	30009.	10003.	58.00
ROUTED TO	3	5303.	5193.	4644.	3169.	58.00

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HEC-1 VERSION DATED JAN 1973

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DAM SAFETY INSPECTION - NEW HAMPSHIRE
SQUAM LAKE DAM - WITH STOPLOGS INPLACE TO ELEVATION 563
ONE HALF OF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	30	0	0	0	0	0	0	0

JOPER	NWT
3	0

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SUB-AREA RUNOFF COMPUTATION

1 INPUT TRIANGULAR SHAPED HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	58.00	0.00	58.00	0.00	0.500	0	0	0

INPUT HYDROGRAPH

0.	2977.	5955.	8392.	11909.	14886.	17864.	20841.	23818.	26795.
29773.	32750.	35727.	38705.	41682.	44659.	47636.	50614.	53591.	56568.
59545.	62523.	65500.	62523.	59545.	56568.	53591.	50614.	47636.	44659.
41682.	38705.	35727.	32750.	29733.	26795.	23818.	20841.	17864.	14886.
11909.	8932.	5955.	2997.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	65500.	56568.	30009.	10003.	1440440.
INCHES		9.07	19.25	19.25	19.25
AC-FT		28064.	59553.	59553.	59553.

RUNOFF MULTIPLIED BY 0.50

0.	1488.	2977.	4196.	8954.	7443.	8932.	10420.	11909.	13397.
14886.	16375.	17868.	19352.	20841.	22329.	23818.	25307.	26795.	28284.
29772.	31261.	32750.	31261.	29772.	28284.	26795.	25307.	23818.	22329.
20841.	19352.	17863.	16375.	14866.	13397.	11909.	10420.	8932.	7443.
5954.	4466.	2977.	1498.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	32750.	28284.	15004.	5001.	720220.
INCHES		4.53	9.62	9.62	9.62
AC-FT		14032.	29776.	29776.	29776.

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THRU SQUAM LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	2	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	32097.	39600.	47000.	51000.	52989.	55000.	59000.	63000.	79000.	130000.
OUTFLOW=	0.	0.	48.	59.	64.	101.	260.	455.	1938.	12191.

TIME	EOP STOR	AVG IN	EOP OUT
1	39600.	0.	0.
2	39630.	744.	0.
3	39723.	2233.	0.
4	39871.	3586.	0.
5	40080.	5075.	1.
6	40357.	6698.	3.
7	40695.	8187.	4.
8	41094.	9676.	7.
9	41555.	11164.	9.
10	42078.	12653.	12.
11	42661.	14142.	16.
12	43306.	15630.	19.
13	44013.	17119.	24.
14	44780.	18608.	28.
15	45609.	20096.	33.
16	46499.	21585.	38.
17	47451.	23073.	44.
18	48464.	24562.	49.
19	49538.	26051.	52.
20	50674.	27539.	54.
21	51871.	29028.	58.
22	53129.	30517.	61.
23	54448.	32005.	66.
24	55766.	32005.	90.
			131.

25	57021.	30517.	181.
26	58212.	29028.	228.
27	59340.	27539.	276.
28	60404.	26051.	328.
29	61404.	24562.	377.
30	62341.	23073.	422.
31	63214.	21585.	474.
32	64024.	20096.	549.
33	64768.	18608.	618.
34	65449.	17119.	682.
35	66065.	15620.	739.
36	66617.	14132.	790.
37	67107.	12653.	835.
38	67533.	11164.	875.
39	67896.	9676.	908.
40	68196.	8187.	936.
41	68433.	6698.	958.
42	68609.	5210.	974.
43	68722.	3721.	985.
44	68774.	2238.	990.
45	68764.	749.	989.
46	68723.	0.	985.
47	68682.	0.	981.
48	68642.	0.	977.
49	68601.	0.	974.
50	68561.	0.	970.
51	68521.	0.	966.
52	68481.	0.	963.
53	68442.	0.	959.
54	68402.	0.	955.
55	68363.	0.	952.
56	68323.	0.	948.
57	68284.	0.	944.
58	68245.	0.	941.
59	68206.	0.	937.
60	68168.	0.	934.
61	68129.	0.	930.
62	68091.	0.	926.
63	68053.	0.	923.
64	68015.	0.	919.
65	67977.	0.	916.
66	67939.	0.	912.
67	67901.	0.	909.
68	67864.	0.	905.
69	67826.	0.	902.
70	67789.	0.	898.
71	67752.	0.	895.
72	67715.	0.	892.
73	67678.	0.	888.
74	67642.	0.	885.
75	67605.	0.	881.
76	67569.	0.	878.
77	67532.	0.	875.
78	67496.	0.	871.
79	67460.	0.	868.
80	67425.	0.	865.
81	67389.	0.	861.
82	67353.	0.	858.
83	67318.	0.	855.
84	67283.	0.	851.
85	67247.	0.	848.

86	67212.	0.	845.
87	67178.	0.	842.
88	67143.	0.	839.
89	67108.	0.	835.
90	67074.	0.	832.
91	67039.	0.	829.
92	67005.	0.	826.
93	66971.	0.	823.
94	66937.	0.	819.
95	66903.	0.	816.
96	66870.	0.	813.
97	66836.	0.	810.
98	66803.	0.	807.
99	66769.	0.	804.
100	66736.	0.	801.
101	66703.	0.	798.
102	66670.	0.	795.
103	66637.	0.	792.
104	66605.	0.	789.
105	66572.	0.	786.
106	66540.	0.	783.
107	66507.	0.	780.
108	66475.	0.	777.
109	66443.	0.	774.
110	66411.	0.	771.
111	66379.	0.	768.
112	66348.	0.	765.
113	66316.	0.	762.
114	66285.	0.	759.
115	66253.	0.	756.
116	66222.	0.	753.
117	66191.	0.	750.
118	66160.	0.	747.
119	66129.	0.	745.
120	66099.	0.	742.
121	66068.	0.	739.
122	66037.	0.	736.
123	66007.	0.	733.
124	65977.	0.	730.
125	65947.	0.	728.
126	65917.	0.	725.
127	65887.	0.	722.
128	65857.	0.	719.
129	65827.	0.	717.
130	65798.	0.	714.
131	65768.	0.	711.
132	65739.	0.	708.
133	65710.	0.	706.
134	65680.	0.	703.
135	65651.	0.	700.
136	65622.	0.	698.
137	65594.	0.	695.
138	65565.	0.	692.
139	65536.	0.	690.
140	65508.	0.	687.
141	65480.	0.	684.
142	65451.	0.	682.
143	65423.	0.	679.
144	65395.	0.	677.
145	65367.	0.	674.
146	65339.	0.	671.

147	65312.	0.	669.	
148	65284.	0.	666.	
149	65257.	0.	664.	
150	65229.	0.	661.	
SUM			100295.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	990.	976.	921.	696.	100295.
INCHES		0.15	0.59	1.34	1.34
AC-FT		484.	1828.	4146.	4146.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	3	32750.	28284.	15004.	5001.	58.00
ROUTED TO	3	990.	976.	921.	696.	58.00

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HEC-1 VERSION DATED JAN 1973
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DAM SAFETY INSPECTION - NEW HAMPSHIRE
SQUAM LAKE DAM - WITH STOPLOGS INPLACE TO ELEVATION 563
PERCENT OF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	30	0	0	0	0	0	4	0

JOPER	NWT
3	0

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SUB-AREA RUNOFF COMPUTATION

INPUT TRIANGULAR SHAPED HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	58.00	0.00	58.00	0.00	0.220	0	0	0

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THRU SQUAM LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	32097.	39600.	47000.	51000.	52989.	55000.	59000.	63000.	79000.	130000.
OUTFLOW=	0.	0.	46.	59.	64.	101.	260.	485.	1938.	12191.

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1901 SOUTH NAVAJO, DENVER, COLORADO 80223

RUNOFF SUMMARY: AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	3	14410.	12444.	6602.	2200.	58.00
ROUTED TO	3	63.	63.	62.	56.	58.00

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COONTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
NH	59	NED	NM	009	02				SQUAM LAKE DAM	4342.3	7137.8	150CT78

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	LITTLE SQUAM LAKE + SQUAM LAKE

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	05	SQUAM RIVER	ASHLAND	1	1599

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES (27) MAXIMUM (ACRE–FT.)	(27) NORMAL (ACRE–FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
CTREGRPG	1927	RC	22	18	44000	39600						

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	182	C	22	1470												

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
NH WATER RES BD	I W JONES CO	

(49) REGULATORY AGENCY DESIGN	(50) CONSTRUCTION	(51) OPERATION	(52) MAINTENANCE
NONE	NONE	NONE	NONE

(53) INSPECTION BY	(54) INSPECTION DATE DAY | MO | YR	(55) AUTHORITY FOR INSPECTION
HARRIS-ECI ASSOCIATES	05JUN78	PL 92-367

(56) REMARKS